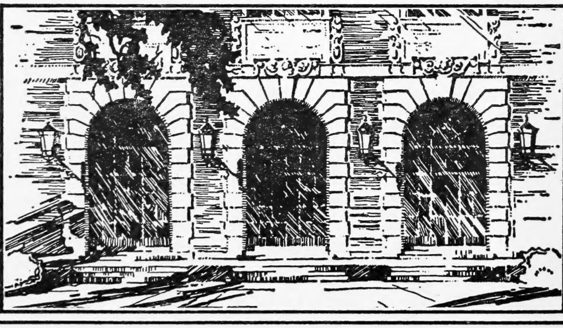

# TRANSACTIONS AND PROCEEDINGS

AND

# REPORT

OF THE

# Philosophical Society

OF

## ADELAIDE, SOUTH AUSTRALIA,

FOR 1878-9.



Adelaide:
PRINTED BY WEBB, VARDON, & PRITCHARD, GRESHAM STREET.
1879.

# Philosophical Society of Adelaide.

Patron:

HIS EXCELLENCY SIR W. F. D. JERVOIS, G.C.M.G., C.B., &c.

President:

PROFESSOR RALPH TATE.

Vice-Presidents:

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Hon. Secretary:

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Hon. Treasurer:

THOMAS D. SMEATON, Esq.

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CHARLES TODD, Esq., C.M.G., F.R.A.S., &c.
(REPRESENTATIVE GOVERNOR.)

Assistant Secretary:

MR. A. MOLINEUX.

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# LIST OF MEMBERS, SEPTEMBER 30TH, 1879.

Those marked (F) were present at the first meeting when the Society was founded. Those marked (L) are Life Members. Those marked with an asterisk have contributed papers.

| | | Date of Election. |
|---|---|---|
| HONORARY MEMBERS. | | |
| Angas, Geo. French, F.L.S., C.M.Z.S. | Norland-square, London ... | 1879 |
| Barkely, Sir Henry, G.C.M.G., K.C.B. ... ... ... | ... ... ... | 1857 |
| Ellery, R. L. J., F.R.S. ... ... | Observatory, Melbourne ... | 1876 |
| *(F) Feignagle, C. G. ... ... | Melbourne ... ... | 1853 |
| *Garran, A., LL.D. ... ... | Sydney ... ... ... | 1853 |
| *Hull, H. M. ... ... | Hobart Town ... ... | 1855 |
| Jervois, H. E. Sir W. F. D., G.C.M.G., C.B. ... ... ... | Government House ... | 1878 |
| Little, E. ... ... ... | ... ... ... | 1855 |
| Macleay, W., F.L.S. ... ... | Sydney ... ... ... | 1878 |
| Russell, H. C., B.A., F.R.A.S ... | Observatory, Sydney ... | 1876 |
| Von Mueller, Baron Ferd., K.C.M.G., F.R.S., &c. ... ... | Melbourne ... ... | 1879 |
| Warburton, Col. P. Egerton ... | Beaumont ... ... | 1858 |
| *Wilson, C. A. ... ... ... | Supreme Court ... ... | 1853 |
| *Woods, Rev. J. E. T., F.L.S., F.G.S., &c. ... ... ... | Sydney ... ... ... | 1877 |
| (F) Young, J. L. ... ... | Parkside ... ... ... | 1853 |
| CORRESPONDING MEMBERS. | | |
| *Hayter, H. H., F.S.S. ... ... | Government Statist, Melbourne | 1878 |
| *Scoular, Gavin ... ... ... | Blair, Smithfield ... ... | 1878 |
| *Tepper, Otto ... ... ... | Ardrossan, Yorke's Peninsula | 1878 |
| ORDINARY MEMBERS. | | |
| Adamson, Adam, jun. ... ... | Angas-street ... ... | 1878 |
| *Adamson, D. B. ... ... | Angas-street ... ... | 1867 |
| Addis, W. L. ... ... ... | Currie-street ... ... | 1879 |
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| Bagot, U. N. ... ... ... | Melbourne-street, N. Adelaide | 1877 |
| Biggs, Col. J. H. ... ... | Edwardstown ... ... | 1878 |
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| Brookes, Joseph ... ... | Survey Office ... ... | 1877 |
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| Brunskill, George, J.P. ... ... | Morgan ... ... ... | 1878 |
| Burgan, T. ... ... ... | Gilles-street ... ... | 1858 |
| *Chalwin, Thomas ... ... | Currie-street ... ... | 1877 |
| Chapple, F., B.A., B.Sc. ... | Prince Alfred College ... | 1876 |
| Coffee, F. R., C.E. ... ... | Engineer-in-Chief's Office ... | 1879 |
| *(L) Cooke, E., M.P. ... ... | South-terrace ... ... | 1876 |
| Crawford, F. S. ... ... | Surveyor-General's Office ... | 1865 |
| *Davenport, S. ... ... ... | Beaumont ... ... | 1856 |
| Davidson, Rev. Professor, University of Adelaide ... ... ... | Jeffcott-street, N. Adelaide ... | 1876 |
| Dobbie, A. W. ... ... ... | Gawler-place ... ... | 1876 |

| | | |
|---|---|---|
| Duffield, W ... ... ... | Gawler ... ... ... | 1859 |
| Elder, Sir Thomas ... ... | Grenfell-street ... ... | 1871 |
| *Fletcher, Rev. W. R., M.A. ... | North-terrace, Kent Town ... | 1876 |
| Gall, D. ... ... ... | Tynte-street, N. Adelaide ... | 1865 |
| Giles, E. W. ... ... ... | Government Offices ... ... | 1877 |
| *(F) Gosse, William, M.D., F.R.C.S. | North-terrace ... ... | 1853 |
| Gosse, Chas., M.D. ... ... | North-terrace ... ... | 1877 |
| *Gunson, J. M., M.D. ... ... | Kent-terrace, Norwood ... | 1877 |
| *Hamilton, George, Commissioner of Police ... ... ... | Adelaide Club ... ... | 1868 |
| Harrold, Arthur ... ... | Hindley-street ... ... | 1876 |
| Harry, Thos. ... ... ... | Penn Chambers ... ... | 1878 |
| Hay, Hon. Alexander, M.L.C. ... | Beaumont ... ... | 1861 |
| Hickson, R., M.I.C.E., Engineer of Harbours and Jetties ... ... | Unley ... ... ... | 1876 |
| *Hill, W. ... ... ... | Kensington-road ... ... | 1874 |
| *Hosking, J., Inspector of Schools ... | Brown-street ... ... | 1855 |
| Hull, W. B., C.E., Assistant Hydraulic Engineer ... ... | Hydraulic Engineer's Office ... | 1874 |
| Hullett, J. W. H., C.E. ... ... | Port Augusta ... ... | 1876 |
| *Ingleby, R., Q.C. ... ... | Carrington-street ... ... | 1861 |
| Johnson, J. A. ... ... ... | Alfred Chambers, Currie-street | 1875 |
| *(F) Kay, R., Secretary South Australian Institute ... ... | College Town ... ... | 1853 |
| Knevett, S. ... ... ... | Carrington-street ... ... | 1878 |
| *Lamb, Professor Horace, M.A. University of Adelaide ... ... | Medindie ... ... | 1876 |
| *Laughton, E. ... ... ... | King William-street ... | 1874 |
| Lees, S. E. H. ... ... ... | Survey Office, Adelaide ... | |
| *Lloyd, J. S. ... ... ... | Lefevre-terrace, N. Adelaide... | 1856 |
| *Macgeorge, Jas. ... ... | Green's Exchange ... ... | 1855 |
| Madley, L. G., Principal of Training College ... ... ... | Grote-street ... ... | 1879 |
| Magarey, T. ... ... ... | Enfield ... ... ... | 1861 |
| Magarey, A. T. ... ... ... | Barton-terrace, N. Adelaide ... | 1873 |
| *Magarey, S. J., M.B. ... ... | North-terrace ... ... | 1874 |
| Mayo, G., M.D. ... ... | Morphett-street ... ... | 1853 |
| Mayo, G. G., C.E. ... ... | Engineer-in-Chief's Office ... | 1874 |
| *Murray, A. ... ... ... | Coromandel Valley ... | 1858 |
| (L) Murray, David ... ... | Hutt-street ... ... | 1859 |
| Nesbit, E. P., jun. ... ... | King William-street ... | 1875 |
| *Ponton, T. G., F.Z.S. ... ... | Belgrave-terrace, Victoria-sq. | 1877 |
| Rees, Rowland, M.P., C.E. ... | Waymonth-street ... ... | 1874 |
| Russell, W. ... ... ... | Commercial-rd., Port Adelaide | 1879 |
| *Rutt, Walter, C.E. ... ... | Engineer-in-Chief's Office ... | 1869 |
| Sanger, E. B. ... ... ... | Glenelg ... ... ... | 1879 |
| Sawtell, T. H., M.R.C.S. ... | North Adelaide ... ... | 1878 |
| *Schomburgk, R., Doctor Ph., &c. Director ... ... ... | Botanic Gardens ... ... | 1865 |
| *Smeaton, T. D. ... ... | Bank of South Australia ... | 1857 |
| Smith, R. Barr ... ... | Torrens Park, Mitcham ... | 1871 |
| Sparks, H. Y. ... ... ... | Glenelg ... ... ... | 1878 |
| Stuckey, J. J., M.A. ... ... | Victoria Chambers, King William-street ... ... | 1878 |
| *Tate, Prof. Ralph, F.G.S. University of Adelaide ... ... | Buxton-street, N. Adelaide ... | 1876 |
| Thomas, J. Davies, M.D. ... | North-terrace ... ... | 1877 |

| | | |
|---|---|---|
| Thomas, R. G., Sec. of Board of Health ... ... ... | Unley ... ... ... | 1877 |
| Thow, W., Locomotive Engineer ... | S.A. Railways ... ... | 1878 |
| *Todd, Charles, C.M.G., F.R.A.S., M.S.T.E., Postmaster - General, Observer, and Superintendent of Telegraphs ... ... ... | Observatory ... ... | 1856 |
| Tomkinson, S. ... ... ... | Mount Lofty ... ... | 1876 |
| Townsend, W., M.P. ... ... | King William-street ... | 1878 |
| *Verco, Joseph C., M.D. ... ... | Wellington-square, N. Adelaide | 1878 |
| Vickery, G. ... ... ... | Meadows ... ... ... | 1868 |
| Ware, W. L. ... ... ... | Victoria Chambers, King William-street ... ... | 1878 |
| *Waterhouse, F. G., C.M.Z.S., &c., Curator of Museum ... ... | S. A. Institute ... ... | 1859 |
| Way, His Honor, S. J., C.J. ... | North Adelaide ... ... | 1859 |
| Way, Dr. E. W. ... ... | North-terrace ... ... | 1878 |
| Wragge, C. L., F.R.G.S. ... | Care of R. Ingleby, King William-street ... ... | 1877 |
| Wyatt, Wm., M.D. ... ... | Burnside ... ... | 1859 |

ASSOCIATES.

| | | |
|---|---|---|
| Smeaton, Stirling ... ... | Medindie ... ... | 1878 |
| Tate, Thos. ... ... ... | Fowler's Bay ... ... | 1879 |

# RULES.

ADOPTED MAY 21, 1878.



WHEREAS "THE ADELAIDE PHILOSOPHICAL SOCIETY" is incorporated with the South Australian Institution, under the provisions of the South Australian Institute Act, 1863, and it is desirable to consolidate and alter the Rules and Regulations at present existing, it is therefore agreed that the Society shall be governed by the following Rules and Regulations, to the exclusion of all previous rules and regulations :—

1. The title of the Society is "THE ADELAIDE PHILOSOPHICAL SOCIETY."

2. The objects of the Society are the diffusion and advancement of the arts and sciences by the meeting together of the members for the reading and discussion of papers connected with the above subjects, and by other approved means.

3. The Society shall consist of the present members, and of such persons as shall be hereafter elected members.

4. The members shall be classed as follows :—Ordinary Members, Corresponding Members, Honorary Members, and Associates, all of whom shall be elected by ballot.

5. His Excellency the Governor of South Australia for the time being shall be requested to be the Patron of the Society.

FEES.

6. Ordinary members shall subscribe £1 1s. per annum, payable in advance on the 1st day of November to the Honorary Secretary.

7. A member may at any time compound for future annual contributions, that of the current year exclusive, by the payment of the sum of £10 10s.

8. Ordinary members elected during the first half of the financial year shall, within one month after election, pay the full annual subscription of one guinea ; but if elected during the second half of the year, they shall pay the sum of half a guinea only as subscription for the remainder of the financial year.

9. Any person who has not paid the year's contribution on or before the 1st day of January shall cease *ipse facto* to be a member of the Society ; provided always, that written application for the same shall first have been made by or on behalf of

the Treasurer; and provided also, that the Council shall have power to restore the defaulter's name at his request, and after payment of arrears.

### Election of Ordinary Members.

10. Every election of a member into the Society shall take place at an Ordinary Meeting only.

11. Every candidate for admission into the Society must be recommended by two members. The certificate setting forth the names, address, and occupation of the candidate, with the names of his proposer and seconder, shall be sent to the Secretary, and shall be read at a meeting of Council, and also at the following meeting of the Society, and the ballot shall take place at the next following Ordinary Meeting of the Society.

12. The election of members shall be by ballot, one negative in six excluding; and no candidate having been excluded shall be again proposed for admission during the current year.

13. Persons elected shall have immediate notice thereof transmitted to them by the Secretary, accompanied with a copy of the Rules.

14. Members have a right to vote at all meetings, to propose candidates for admission into the Society and into the Council of the Society, subject to the Rules touching the election and constitution of the Society. They are eligible to be members of the Council, and shall have access to the library, and shall be furnished with a copy of any transactions, proceedings, or journal which may be published by the Society.

### Honorary and Corresponding Members.

15. The Honorary Members shall be persons distinguished for their attainments in science, literature, or art.

16. The Corresponding Members shall be persons residing beyond ten miles from Adelaide, who, by furnishing papers or otherwise, may have promoted the objects of the Society.

17. Every person proposed as an Honorary or Corresponding Member shall be recommended by the Council, and be balloted for as in the case of ordinary members.

18. Honorary or Corresponding Members shall be exempted from payment of fees; they may exercise the privileges or perform the duties of an Ordinary Member, except that they shall not vote or otherwise interfere in the business of the Society, or hold office or seat on the Council.

### Associates.

19. Associates shall consist of young men of not more than 21 years of age, and of ladies.

20. Associates shall subscribe 5s. per annum, payable in

advance on the 1st day of November, to the Honorary Secretary.

21. The election of Associates shall be after the same manner as in the case of ordinary members.

22. Any Associate failing to pay his or her subscriptions within one month of notice of election, or who shall be three months in arear with his or her subscription shall cease to be an Associate.

23. Associates shall enjoy all the privileges of members excepting those of taking part in the management of the affairs of the Society, of voting, and of introducing visitors.

24. Any Associate shall be entitled to become an ordinary member of the Society at the first ordinary meeting following the receipt of his application for membership.

### Meetings.

25. Meetings of the Society shall be convened by circular to the members resident in the colony. The circular shall state the subjects to be brought before the meeting, the names of the candidates for membership, and any notice of motion.

26. Meetings of the Society shall be held on days to be fixed by the Council; and as far as practicable one meeting shall be held in each month. Each meeting to commence at half-past 7 o'clock p.m.

27. The President, or in his absence one of the Vice-Presidents, shall take the chair; and in the event of the absence of all the above, the members present shall elect a Chairman.

28. The business at the Society's meetings shall be transacted in the following order, unless it be specially decided otherwise:—

- I. The reading and confirming the minutes of the last meeting.
- II. The nomination of candidates for membership and associateship; and the election of members and associates.
- III. Vacancies among officers, if any, to be filled up.
- IV. The transaction of the ordinary business.
- V. Motions to be considered, and notices of motion for next meeting to be read.
- VI. The consideration of any special matters which members may desire to bring forward subject to the approval of the Chairman obtained before the commencement of the meeting.
- VII. At 8 o'clock the paper or subject notified in the circular shall be read.

29. Any member shall be allowed to introduce two visitors upon entering their names in the Visitors' Book. But no visitor shall speak at a meeting of the Society unless specially invited to do so by the Chairman.

30. No paper shall be read at any meeting which has not been previously notified to the Council.

31. Every paper read before the Society shall be the property thereof, and immediately after it has been read shall be delivered to the Secretary and shall remain in his custody.

32. An annual general meeting of members duly convened by circular shall be held in the month of October at half-past 7 o'clock in the evening, on such day as the Council may appoint. In the event of less than ten members being present, it shall not be lawful for the meeting to proceed to business except for the purpose of adjournment, and the meeting shall stand adjourned to a day and time then resolved upon.

33. At the adjourned meeting the members then present may proceed to business although ten members may not be present.

34. The Council shall call a special meeting of the Society, on receiving a requisition in writing, signed by ten members of the Society, specifying the purpose for which the meeting is required, or upon a resolution of its own. No other business shall be entertained at such meeting. Notice of such meeting, and the purpose for which it is summoned, shall be sent to every member at least seven days before the meeting. Ten members to form a quorum.

35. One member of the Society, not being a member of the Council, shall be chosen at the meeting of the Society next before the month of October in each year as auditor of accounts and balance-sheet of the Society, and shall examine and certify the same prior to the meeting in October.

## THE COUNCIL.

36. The officers of the Society shall be a President, two Vice-Presidents, a Treasurer, and a Secretary, who, with four other members, shall constitute the Council.

37. The Council, on its first meeting, shall appoint one of its members to represent the Society at the Board of Governors of the South Australian Institute.

38. The Council shall have the management of the affairs of the Society.

39. The Council shall meet once in every month for the transaction of business at such time and place as may be appointed. Special meetings of the Council may be convened at any other time on the authority of the President, or of three members of the Council. Due notice of all Council meetings to be sent to each member.

40. No business shall be transacted at any meeting of the Council unless at least four members of the Council are present. In case of equality of votes the Chairman shall have an additional or casting vote.

41. It shall be the duty of the Council to decide on the papers to be read at the monthly meetings, whether by members or non-members; to determine as to the publication, in whole or in any part, of any paper so read; to prepare a report of the proceedings of the Society for the preceding year, and a balance-sheet of the Society's funds, for presentation at the meeting of the Society held in the month of October; and generally so transact the ordinary affairs of the Society.

42. Any member of Council personally interested in a question before the Council shall withdraw during its consideration.

43. Every vacancy in the Council shall be immediately filled up at the next meeting of the Society, and by election by ballot. The member so elected shall occupy the place of the retiring member.

44. Any member of Council absenting himself from three consecutive ordinary meetings of Council without satisfactory explanation shall be considered to have vacated office, and the election of a member to fill his place shall be proceeded with in accordance with Rule 43.

### Election of Officers and Members of Council.

45. All Office-bearers and Members of Council shall retire from office annually at the general meeting in October.

46. The officers and members of Council so retiring shall be eligible for the same or any other office.

47. The President, the two Vice-Presidents, Treasurer, and Secretary shall be separately elected by ballot (should such be demanded) in the above-named order, and the four vacancies in the Council shall be filled up together by ballot at the general meeting in October.

### Secretary.

48. It shall be the duty of the Honorary Secretary to attend and take minutes of the proceedings of the Society and Council respectively, to make the necessary arrangements for meetings, to issue the required notices, to collect the annual subscriptions and to pay them to the Treasurer, to take charge of all the property under the control of the Society; and generally to transact the ordinary routine business of the Society.

### Treasurer.

49. It shall be the duty of the Treasurer to receive all funds belonging to the Society, to pay all accounts approved by the Council, and to render annually an account of all moneys received and expended during his year of office.

### Alteration of Rules.

50. The Rules and Regulations of the Society shall not be

altered unless a written notice of motion, signed by not less than five members, be given at a meeting of the Society; and thereupon such motion may be brought forward at the next meeting.

51. Any resolution passed as above altering or repealing the Rules and Regulations of the Society shall be in force until the meeting held in the month of October following; and if not then confirmed, shall thereafter be held void and of no effect.

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## BY-LAWS RETATING TO COMMUNICATIONS TO THE SOCIETY

1. Every paper which it is proposed to communicate to the Society shall be forwarded to the Hon. Secretary for the approval of the Council at least fourteen days before the date of the meeting at which it is desired to be read.

2. The Council may permit a paper written by a non-member to be read if communicated through a member.

3. In the absence of the authors papers shall be read by the Hon. Secretary.

4. No paper or other communication read before the Society shall be published without the consent of the Council.

5. The Council shall decide, not later than at its meeting next following the reading of a paper, whether it shall be printed in the transactions, and if not such paper shall be returned if desired to the author.

6. All communications intended for publication by the Society shall be clearly and legibly written on one side of the paper only, with proper references, and in all respects in fit condition for being at once placed in the printer's hands.

7. In order to ensure a correct report the Council request that the paper shall be accompanied by a short abstract for newspaper publication.

8. The author of any paper which the Council has decided to publish will be presented with twenty copies, and he shall be permitted to have not more than one hundred copies printed on making application, as per annexed form, to the Hon. Secretary, and on paying the cost of such extra copies.

9. A proof corrected by the MS. shall be submitted to the author, who shall be allowed to make any reasonable amendments therein upon paying the cost of the alterations.

# TRANSACTIONS, PROCEEDINGS, AND REPORT

OF THE

# Philosophical Society of Adelaide.

FOR 1878-9.

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## ABSTRACT OF PROCEEDINGS.

### ORDINARY MEETING, NOVEMBER 5, 1878.

Professor TATE, F.G.S., President, in the chair.

Dr. Sawtell and Mr. H. Y. Sparks elected ordinary members.

The HON. SECRETARY laid upon the table—"Statistical Register of Victoria for 1877," "Meteorological Observations at Adelaide Observatory, 1877," also for April, 1878.

Mr. THOS. D. SMEATON showed two dissimilar pictures, one being a photographic copy of the other. The original was printed in blue and yellow colours, the blue being very distinct and the yellow scarcely visible. In the photographic copy the yellow came out quite strongly, whilst the blue was nearly absent. The pictures illustrated a new system of bank-note printing, whereby forgery by means of photography can be rendered impossible in the present state of that art.

Mr. CHAS. TODD mentioned an error made by the President in his inaugural address at last meeting, with respect to the space proposed to be devoted to Museum purposes in the projected western wing of the new Institute buildings.

Dr. S. J. MAGAREY read a paper, illustrated by outline map of South Australia, and by diagrams showing thermometrical ranges, degrees of humidity, and deathrates per 1,000 of children under one year of age, in the colonies of Tasmania, New Zealand, New South Wales, Queensland, Victoria, and South Australia, entitled "Our Climate, and Infant Mortality." (See page 1.)

Discussion ensued.

Mr. G. H. HAMILTON asked if it could not be fairly assumed that the excess of infant mortality in large centres of population, such as Port Adelaide and towns on Yorke's Peninsula, was attributable to the enfeebled constitutions of many of the parents, caused by drink and other vices.

Mr. R. Ingleby thought the paper just read was one of the most valuable that had ever been read before the Society. The conclusions arrived at by Dr. Magarey fully confirmed his own observations. He did not know whether intemperance in the parents affected the question or not, but pointed out that in the mining districts of Yorke's Peninsula and at Port Adelaide, where the greatest mortality amongst infants prevailed, there were the greatest numbers of teetotallers. (Hear, hear, and "It was the drunkenness that was the cause of the teetotalism.") He proposed a vote of thanks to Dr. Magarey.

Dr. J. M. Gunson seconded. He did not think that vice and intemperance in the mother was the cause of the excess of deaths of infants under one year in South Australia, for the women in Victoria were quite as vicious and intemperate, and yet the infant deathrate was less per 1,000. The sanitary state of the city in respect to drainage could be tested by the prevalence or absence of typhus or typhoid fever, and in Adelaide during the past year there had been less of this fever than for some time previously. He agreed with Dr. Magarey that the extreme heat and dryness of our summer days was the cause of the excess of infant deaths as compared with the other colonies. At first the heat had a stimulating effect, but afterwards a reaction was set up, and then it became depressing. This was illustrated by the activity displayed by adults during the first days of a hot period, and the lassitude experienced towards the end. He alluded to the necessity for supplying infants with moisture or water in the hot weather, and for being more careful in regulating the clothing to the heat indicated by the thermometer. The question suggested itself—"Can we adopt any method of making the climate cooler?" The influence of trees on climate was well known. The leaves during the day absorbed solar heat, reducing the temperature, and converting heat energy into vital energy; leaves had also a strong purifying effect upon the atmosphere, and, by exhalation, tended to produce a healthy humidity in the air. There was an enormous surface in inches of leaf-surface in one of our large eucalypts, and the evaporation of moisture from any such surface was far greater than that which was received from an equal space of atmosphere by precipitation. If the Park Lands and open spaces were planted with trees, shrubs, and flowers, instead of being left dry, parched, and arid, as at present, not only would the space be made more healthy, but the city would be rendered far more attractive and agreeable to our visitors.

Mr. Charles Todd suggested that breaking up the soil and planting belts of trees in an east and west direction would have a beneficial influence. He thought Dr. Magarey had not laid sufficient stress upon the great and sudden fluctuations of temperature—sometimes as much as 45 deg. in 24 hours. These fluctuations, probably, had much influence on infant mortality, more than if the rise and fall were more gradual. He had noticed in the Northern Territory, Queensland, and other similar countries, that women stood the moist heat better than men. With regard to the diagrams, he was hardly prepared to find so great a range in Queensland.

Mr. W. Rutt, referring to the diagram showing mortality, temperature, &c., suggested that temperature rather than dryness had the greater effect upon human life. It had been suggested that intemperance in parents was a cause of infant deaths in centres of population such as Port Adelaide and on Yorke's Peninsula, but he pointed out that intemperance and teetotalism were co-existent in those localities.

Dr. Magarey explained that his map was compiled from the official returns of the Registrar-General, which gave the deaths for each district, and that would account for the district of Yorke's Peninsula being coloured so deeply, whilst the adjoining district of Kangaroo Island, containing few inhabitants, was comparatively colourless.

Professor Tate was much pleased with the map in most particulars, but of course it was too highly coloured in some localities. The population of the Peninsula was centralised at the mines, but was sparse in the other portions. In reality, the southern end being almost surrounded with water and therefore possessing a cool and moist atmosphere, ought to be as healthy as Kangaroo Island.

Mr. R. Ingleby suggested that the upper storeys of houses should be more used for living rooms, in which the inhabitants would escape the dangers arising from bad drainage and noxious gases. He thought the extensive use of Glen Osmond stone was one cause of the great heat experienced in Adelaide. The walls became thoroughly heated, and absorbed a great deal more heat than white stone would do.

Mr. Magarey, senr., thought if white stone were used, instead of blue slate, for pavements, ophthalmia would be far more prevalent through radiation and reflection of light. In Tasmania there were very many old people, and naturally there would be a greater proportion of deaths of adults than of infants. In New Zealand, where towns were more scattered, the deaths were, comparatively, not so numerous—especially on the elevated lands—but in the lower and thickly-populated towns the deathrates were much higher. In planting trees he thought they should not forget the wattle, the gum of which, eaten in quantities by children, seemed to be beneficial to them. The acid principle contained in the sheaoak apples also seemed to be beneficial to them. He considered Port MacDonnell a more healthy place for summer resort than either Victoria, Sydney, or Tasmania. He considered a railway to the hills a matter of national importance, as by that means persons engaged in town during the heat of the day in summer could retire to the hills at night and recuperate their exhausted energies. In his experience with children—and he had brought up a few—he found that they throve when allowed to sleep and play in the lower rooms during hot weather, but when kept on the second floor they drooped, and when taken to the top storey they became prostrated—proving that coolness was necessary to their health.

Mr. G. H. Hamilton wished some one would speak a good word for our climate. What with Glen Osmond stone, blue slate, heat, &c., a stranger would think we possessed a climate like that of Cape Coast Castle. He arrived in the colony at a very early period in its history, and had managed to live through all the fearful and fatal changes of temperature. He had not found the climate affect him since his arrival in 1839, but then he was more than one year old.

Dr. J. M. Gunson remarked that the comparisons of infant mortality made that evening were between the Australian colonies only, in which comparisons South Australia came out unfavorably; but our deathrate was not so great as in England, and it was considerably lower than in many other countries.

Dr. S. J. Magarey said he had stated that our climate was favorable to adults. He found that the upper rooms in his house were much warmer than the lower, the top rooms being hot, the next below being warm, and the lowest cool. He believed the planting of wattles would be beneficial in many ways. He had found an infusion of the bark very useful in some cases during his practice.

Mr. Adamson suggested that Dr. Gunson should give a paper upon "Tree-planting, and its effect upon Climate."

Dr. J. M. Gunson promised if possible to do so.

The vote of thanks to the author was carried.

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## Ordinary Meeting, December 3, 1878.

Professor R. Tate, F.G.S., President, in the chair.

The Hon. Secretary laid upon the table—"The Victorian Year Book," by H. H. Hayter; "On Evaporation, Rainfall, and Elastic Force of Vapour," by J. R. Mann.

Mr. E. W. Way, physician, was nominated as an ordinary member, and Mr. E. H. Lees, surveyor, was elected an ordinary member.

Professor TATE mentioned that in Mr. Rawlinson's recent lecture upon "Our Water Supply" it was suggested that much of the salt water in South Australia might be attributed to sea water enclosed by upheaval of surrounding land and evaporated. He had seen a pit at North Adelaide, sunk to a depth of fifteen feet, and was led to a different conclusion. The first six feet from the surface was composed of travertine, the top being very dense, the remainder becoming softer until it might be compared to marl. The rest of the depth consisted of red and blue clay, on the top of which brackish water was obtained. Deep beneath this clay came marls, filled with marine fossils. He thought the red and blue clays were the result of deposit under circumstances unfavorable to animal life, such as a mixture of salt and fresh water. The fact that fresh water could be obtained by sinking through these strata, and by keeping back the soakage from above, he thought proved that the salt in the upper strata was obtained by concentration of the saline ingredients of surface soakage.

Prof. TATE showed a fossil head and shoulders of a fish found in the marine limestone of Morgan, Murray River, which he described as unique. The sclerotic ring, encircling the eye, was well preserved; the dorsal fin and spines were very stout and long, and the pectoral fins were also well developed. The scales were large and distinct, greatly resembling those of a schnapper, but apparently stouter. The ctenoid scales proved it to be a perch, probably resembling the Beryx, a sea perch now existing, fossils of which had been found in the chalk formation.

Mr. C. A. WILSON read a letter (illustrated by a map and a book of coloured drawings) received by him from his nephew, the Rev. C. T. Wilson, Missionary to the first and second parties sent by the Church of England Missionary Society to the Victoria Nyanza, in Central Africa, of both of which parties he is the sole survivor—the first having been destroyed by fever, and the second massacred by the natives.

The Hon. B. T. FINNISS read a paper upon "The Philosophy of Consciousness."

Votes of thanks were accorded to both gentlemen.

It was resolved that Mr. Finniss's Paper should be discussed at the next meeting.

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ORDINARY MEETING, JANUARY 7, 1879.

Professor R. TATE, F.G.S., President, in the chair.

The HON. SECRETARY laid upon the table six papers upon conchology—chiefly South Australian shells—by G. F. Angas, Esq.; a list of the publications of the South Australian Institue; Australian Statistics, by H. H. Hayter.



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Dr. E. Way was elected an ordinary member.

Letter and report of Committee received from Adelaide University in reply to communication forwarded by the Council of Philosophical Society, in February, 1877, urging the importance of providing special training for students in mining engineering. Report dated December, 1878, as follows:—

"Your Committee have the honour to report—1. That they have carefully considered the Adelaide Philosophical Society's resolution urging on the Council the great importance of providing special training for students in mining engineering, and the Society's suggestion to add to the University curriculum such special subjects as will carry out the object of the resolution until the Government is in a position to take up the subject more fully. 2. In considering the foregoing resolution and suggestion your Committee have been greatly aided by the valuable reports furnished by Captain Hancock, Mr. Higgs, and Professor Tate, and by various papers and reports as to the School of Mines at Ballarat, which the Hon. the Minister of Education has obligingly procured from the Government of Victoria. 3. From the documents referring to the School of Mines at Ballarat it appears that the institution expends about £1,800 per annum, and although the University is only requested to add special subjects to its curriculum your Committee are of opinion that the efficient teaching of those subjects would necessitate a larger staff of lecturers and an increased expenditure in other ways which they cannot recommend to the Council to undertake at present. 4. Your Committee do not believe that a sufficient number of students would avail themselves of the 'special training,' and of the instructions in special subjects recommended by the Philosophical Society to justify the Council in incurring the expense necessary for those purposes, and they are also of opinion that the establishment in mining centres of classes for the study of subjects specially connected with a particular industry would be beyond the function of the University. 5. If at any future time a School of Mines shall be established by the Governmgnt or by means of funds specially subscribed for that purpose it may be properly affiliated to this University, but your Committee are of opinion that to comply with the suggestions of the Philosophical Society would at present be premature. 6. Your Committee beg to recommend that a copy of this report be transmitted to the Society with an expression of the Council's regret that they find themselves unable for these and other reasons to adopt the Society's suggestions on the very important subject to which its resolution is directed.—S. J. Way, Vice-Chancellor, December 6, 1878."

Mr. W. Rutt moved—"1. This Society views with concern the depressed state of the mining interest in this colony, and the possibility of a long continuance of the present low price of copper, and feels that the only hope of reviving this interest lies in a greater economy of production, resulting from the intelligent application of science to the processes of seeking, raising, and treating the ores.

"2. While thanking the Council of the University for the careful consideration which it has given to the suggestions contained in the letter forwarded from this Society on the 20th February, 1877, and acknowledging the force of the objections raised by the Council to the establishment by the University of a department commensurate with the School of Mines at Ballarat, the Society begs to suggest to the Council that its curriculum already comprises several branches of knowledge bearing upon this subject, and that by the addition of a comparatively small number of subjects it might arrange for a course of study which would greatly advance the object sought, and would, by giving prominence to the importance of this question, pave the way for a more comprehensive scheme.

"3. This Society believes that although the number of students availing themselves of the suggested course might at first be small, it would rapidly increase, and that the University has in its power to stimulate the desire for higher scientific attainments on the part of those who intend to devote themselves to this important industry, and thus to confer a lasting benefit upon this community."

The motion was carried, the Hon. B. T. Finniss and Professor Tate remarking that they did not think a larger staff was required.

Letter read from Mr. W. McLeay, Sydney, acknowledging the honour done him in electing him honorary member.

Mr. Thomas Tate showed some fine specimen of *Corbicula Angasi* found by him in the Torrens at the Reedbeds.

Professor Tate read some notes upon the Conchology of King George's Sound, concluding with a few remarks upon a new species of *Lepidurus* which he had named *viridulus*.

Discussion upon Hon. B. T. Finniss's Paper, "The Philosophy of Consciousness."

Mr. Harry said crises occurred in the lives of every thoughtful man when the consciousness of existence was unusually strongly marked, and the puzzling question would thrust itself on one, "How is it, not that I exist, but that, existing, I am conscious of my existence?" Man was the only one of which it could be said that he was absolutely conscious of his own existence, and indeed with many of the most thoughtful of the race the two facts in respect to which alone they would undertake to be positive were that they existed and were conscious of that existence. No room was left by the theories laid down by Mr. Finniss for the soul and spirit as distinct from matter, though he did not deny their existence. But those who would summarily dispose of the non-material part of man left out one or two important factors from the calculation of the sum of existence. The passions, fear, hope, joy, grief, love, all the emotions that imparted colour to the ever-changing kaleidoscope of life, were not matter. This admitted, the materialist theory of life was much shaken. Of the two he would rather incline to the transcendental theory, which threw matter rather into the background.

Mr. W. Hill also spoke upon the subject.

The Hon. B. T. Finniss, in reply, said he was glad that the discussion had taken place. Mr. Harry had said he lived, and wanted to know how he lived. That was just the difficulty he (Mr. Finniss) had experienced in writing his paper. He had said that a man being run through by a bayonet felt pain, but how motion of a violent kind became converted into consciousness they could not tell. They knew that every action on the nerves was transmitted to the brain, which received and interpreted it; but they did not know why it was so. He expected that during the discussion the transcendentalist would speak out and oppose him on some of the views on materialist grounds which he had taken. He would like to hear arguments in their favour. They knew that the primary forces of nature existed, and the transcendentalist would have to prove that forces existed independent of matter. But before those proofs were brought he must hold the materialist views he had expressed in his paper. It had been said that consciousness belonged to man alone, but he was of opinion that it was traceable to animals as well. He referred to dogs, and said that they were conscious that they were different from other animals around them. He would be very glad if any one else would throw any more light on the subject.

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## Ordinary Meeting, February 4, 1879.

Mr. D. B. Adamson, Member of Council, in the chair.

The Hon. Secretary laid upon the table—"Statistical Register of the Colony of Victoria for 1877, Part vii., Law, Crime, &c.," by H. H. Hayter.

Mr. Carl Umbehaun elected an ordinary member.

Mr. Thos. Tate elected an associate.

The Chairman (Mr. D. B. Adamson) laid on the table several remarkably fine ears of wheat which had been grown in California by a Mr. Phelps on land which had not had rain upon it from the time of sowing the seed to the time of reaping the wheat. He also stated that Mr. Phelps had raised potatoes on the same field, which were three inches in diameter notwithstanding that no rain had fallen between the sowing of the seed and raising of the crop. These results, it was said, were owing to the natural moisture, and were not due to irrigation.

The ASSISTANT SECRETARY laid upon the table specimens of a substance found on Kangaroo Island, and supposed by the discoverers to be coal, or an indication of coal. It was not claimed that the existence of this substance on the island was a new discovery, but the men stated that they had found the place whence it originated in a spring within a cave on the south coast. In his opinion the substance was a form of petroleum.

The HON. SECRETARY read a paper by Mr. J. D. Woods on "The Aborigines of South Australia." (See p. 81)

A desultory sort of discussion followed, regret being generally expressed that Mr. Woods was not present to supply information upon several matters not touched upon in the paper.

Mr. R. INGLEBY said it appeared to him that there was no accumulation of wealth among the aboriginals, and yet Mr. Woods spoke of the men "buying" their wives. He could scarcely see what the exchange could be. Another matter on which he should like to have heard something was in reference to the custom of some of the blacks of taking a cast of the head of a corpse and allowing it to remain on for some time.

Mr. A. MOLINEUX said he thought it was a practice observed by the female relatives of the deceased, who plastered mud upon their heads and let it remain until it became thoroughly set. They then placed it on the grave of the deceased. He arrived in the colony in 1839, and had seen a great deal of the habits and customs of the blacks. He remembered once seeing the funeral of one of their men, whom they called King John. After death a number of the tribe put him on a lot of sticks, and after smoking him for a considerable time carried him about for nearly a fortnight before the obsequies were finally concluded. During the time there were great lamentations, the "gins" especially making a fearful noise and evincing great distress. Special honor, he thought, was shown to John on account of his position, because he always found that the ordinary members of a tribe were buried without such display, and their bones were broken up and put indiscriminately into the graves. That accounted for the accumulation of bones that were sometimes found on the banks of the Torrens when a landslip had exposed some old native burying ground. Along the banks of the Coorong it was a common practice of the blacks to hide their dead in the branches of trees, and even now the remains were to be seen in the branches of what was known as the cockatoo bush. (Mr. Ingleby—"Hear, hear.") He wondered that Mr. Woods had not referred to the fact.

Mr. R. G. Thomas said Mr. Woods spoke of the Port Jackson blacks using bows and arrows. He had never heard of such being the case, and was sorry Mr. Woods was not present to give his authority. Nothing had been said in the paper about the blacks being specially fond of a particular kind of fat in the body, which they generally took from any human victim who fell into their hands, or even from the dead of their own tribe.

Mr. Ingleby said there appeared, too, to be no doubt that the natives had recognised doctors amongst them. He had heard of the bones of a human skeleton being perfectly articulated by one of their doctors.

Mr. Molineux said with regard to eating fat, he had often heard the blacks speak of killing a native of another tribe for his kidney fat.

Mr. Rutt said with regard to the special honors which seemed to be paid to some natives at their death, he thought it was owing to their royalty. He remembered once a native queen being buried at Upper Kensington with similar rites and ceremonies to those which had been described. In his opinion it was only because of her royal position.

Mr. Molineux said he did not think there was any recognised royal family among the blacks. Any man among them who was of powerful physique or displayed any special daring or intelligence, was respected above all others, and recognised as their great leader or chief.

The Hon. B. T. Finniss said he remembered King John very well. He was a man of very powerful frame and commanding appearance. Reference had been made to the question of half-castes among the blacks. Several theories had been advanced as to whether there was or was not any dislike to them on the part of the blacks. He remembered being at Rapid Bay in 1838, and being camped with a small party, including a few friendly blacks, among whom were a native and his lubra and a half-caste child. The night was very rough, and the child cried a great deal. The black man, however, got up and attended to it, and treated it entirely as his own, and showed anything but a dislike to it.

Mr. Ingleby said in his opinion the blacks showed no special dislike to half-caste children.

Mr. Molineux endorsed Mr. Ingleby's opinion, but said he once heard a black say in reference to a half-caste child that he did not like its red hair, and the mother subsequently confessed to having eaten it because it was too much like "warrigal" (wild dog).

Mr. F. Chapple said he was once at Point Sturt, and drew attention to a half-caste child amongst the blacks, when a resident said to him, "Don't appear to notice it; they don't like it."

The Hon. B. T. Finniss, in referring to many of the extraordinary and revolting customs of the aboriginals at certain periods of life, said in the interests of the Society as a scientific institution he thought a record of them should be preserved, even if the description were given in one of the dead languages. He hoped as Mr. Woods promised to take up the subject again that he would not overlook that point.

On the motion of Mr. Ingleby, seconded by Mr. Chapple, a vote of thanks was accorded to Mr. Woods for his paper.

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Ordinary Meeting, March 11, 1879.

Mr. Rupert Ingleby, Q.C,, Vice-President, in the chair.

The Hon. Secretary laid upon the table—

"Statistical Register of Victoria, 1877," Parts VIII. and IX.

"Observations at Adelaide Observatory," May and June, 1878.

Circulars *re* Melbourne Exhibition.

Dr. J. C. Verco was elected a member of the Council, *vice* Jas. MacGeorge resigned by non-attendance.

Dr. J. C. Verco read a paper upon "Statistics of Consumption in South Australia," (see page 11).

Mr. Thos. D. Smeaton thought immigration influenced the statistics of consumption in this colony, which, having the reputation of possessing a dry climate, was resorted to by persons suffering from that complaint in the hope of deriving benefit from so doing. He had made a diagram, and found that between the ages of 15 and 45 more died than were born, which showed the effect of immigration, and that the large bulk of the population were aged between those years.

Mr. Rutt suggested that Dr. Verco should move with a view to getting the information desired inserted in the return.

Mr. Ingleby said there was no power to compel the doctors to fill in the returns.

A gentleman observed that children inherited consumption, even though the parents came here and recovered their health.

Dr. Verco agreed with Mr. Smeaton in thinking that the number of deaths registered as having occurred from consumption was masked by immigration, and that it arose very largely from immigration of persons suffering, who before leaving home or very soon after arrival were consumptive. It would be well if the doctors could be induced to fill up in their returns the time at which persons dying came into the colony.

ORDINARY MEETING, APRIL 1, 1879.

Professor TATE, F.G.S. (President) in the chair.

The HON. SECRETARY laid upon the table—

"The True Theory of the Earth, and Philosophy of the Predicted 'End,'" by an anonymous author.

"Observations at the Adelaide Observatory," July, 1878.

"Annual Report, Adelaide Botanic Garden."

Professor TATE said at an early date it would give him pleasure to supplement the information which had already been published respecting his recent trip to Eucla, and also to illustrate his paper with specimens of various kinds, provided he could get them ready in time.

Mr. U. N. BAGOT suggested that in view of the present interest taken by the public in the subject, some information upon the subject of artesian wells would be useful.

Professor TATE did not agree with Mr. Bagot in that matter. It was not within the province of the Philosophical Society to institute lectures upon such matters as could be found in ordinary text-books, and he considered that persons who were perhaps interested pecuniarily in the matter should not be enabled to come there and receive for nothing information for which they would otherwise have to employ professional assistance in obtaining.

The HON. SEC. then read a paper, written by Mr. OTTO TEPPER, upon "The Rocks and Cliffs of Ardrossan" (see p. 71), illustrated with coloured sections, sketches and diagrams.

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ORDINARY MEETING, MAY 26, 1879.

Professor R. TATE, F.G.S., President, in the chair.

The HON. SECRETARY laid upon the table—

"Observations at the Adelaide Observatory," September, 1878.

"Statistics of Victorian Friendly Societies," by H. H. Hayter.

"Index to Victorian Statistics."

The CHAIRMAN congratulated the members upon the increased interest taken in the Society, as evidenced by the late accessions of members, and trusted that this would lead to more work being accomplished. He mentioned that copies of the "Journal of Proceedings and Reports" were ready for distribution to such of the members as had paid up their subscriptions.

Mr. F. CHAPPLE, B.A., B.Sc., then took the chair.

Professor TATE read a paper upon "The Physical Features and Natural History of the Country around the Great Bight," illustrated by diagrams and specimens.

Mr. S. TOMKINSON suggested a continuance of the paper at some future time.

It was resolved that all discussion upon the subject should be postponed to a future date, and Professor TATE promised to exhibit his specimens again.

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ORDINARY MEETING, JUNE 3, 1879.

Professor R. TATE, F.G.S., President, in the chair.

The HON. SECRETARY laid upon the table—

"Transactions of the Royal Society of Victoria." vol. 15.

"Results of Rain Observations in New South Wales during 1878," by H. C. Russell, B.A., F.R.A.S.

"Some Talk about the Great Tidal Wave of May, 1877," by J. C. Josephson, C.E.

The following persons were elected ordinary members:—

William Addis, merchant, Currie-street, Adelaide.

Edward F. Broom, accountant, Victoria-square, Adelaide.

Francis F. Coffee, C.E., Engineer-in-Chief's Office, Pirie-street, Adelaide.

Louis G. Madley, Principal of Training College, Grote-street, Adelaide.

Edward B. Sanger, naturalist, Glenelg.

A specimen of *Paradisea regia*, sent to the Museum by Mr. C. Peacock, was exhibited.

Mr. D. B. ADAMSON produced a sheet of fungus, presenting the colour and general appearance of tanned sheepskin, about one-eighth of an inch in thickness, which he had taken from between the annular layers of a red gum log. On touching a piece of this substance with fire it burned like touchwood.

Mr. CHARLES TODD, Chief Government Astronomer, offered some remarks upon the approaching conjunction of Mars and Saturn.

Mr. CHARLES TODD then took the chair, and the adjourned discussion upon Professor TATE's paper upon "The Physical Features and Natural History of the Country around the Great Bight" was resumed.

Mr. S. TOMKINSON complimented the Professor for so boldly expressing his opinion with regard to the improbability of finding water in the country referred to, though it was known that such an opinion would be unpopular. The Government had wisely availed themselves of the services of the Professor, and now that he had reported upon it, they might with magnanimity leave it to the natives, who best knew how to avail themselves of its resources.

The Hon. B. T. FINNISS wished to ask to what geological age the cliffs of the Great Bight might be assigned, and if they were contemporaneous with the chalk cliffs of England?

Professor Tate read a portion of his paper in which he expressed his opinion on that point. (See page 94.)

Mr. T. G. Ponton, F.Z.S., asked whether the skulls of the natives of the Bunda Plateau were different from those of the tribes nearer Adelaide.

Professor Tate had not studied the matter, but he had brought back material for those who were interested in the subject. He considered the Murray natives superior to those near Adelaide, and those living outside the Bunda Plateau were superior to those living within its confines, who were very thin in the body and had narrow and elongated heads. He mentioned several distinguishing peculiarities in the natives of the Bunda region, which perhaps were due to the great privations which they underwent. They partly obtained their subsistence by digging out the great wombats, and it sometimes occupied them several days in digging out a single burrow. The natives used a pointed stick for digging with, and a stick also tipped with flint for killing the wombats. They did not appear to be capable of hunting the kangaroo, and did not use a throwing-stick, as do the natives to the eastward about Fowler's Bay. The natives arrived at maturity very early, and the women were old at thirty. The skull from the Bunda region, which he produced, compared very unfavourably with those of the Murray tribes.

The Hon. B. T. Finniss asked if the Professor had noticed whether the incisor teeth were like molars?

Professor Tate, in reply, referred to the skull of a Eucla native, in which the incisor teeth had broadish crowns.

Mr. Chas. Todd spoke of the value of the paper, and thought that at some future time Professor Tate might be able to offer some observations upon the springs extending almost up to Charlotte Waters. He understood that the longest drought made no difference in those springs, so they must have a strong source somewhere. From the MacDonnell Ranges the watercourses were of considerable length. With regard to the Bunda region, it had been Professor Tate's interest and anxiety to find water, and, in spite of his bad success, he could not but admire the ability and enterprise he had brought to bear upon the work.

The Hon. B. T. Finniss read a paper upon "Will: the Effect of Physical Forces acting on the Brain," in which he referred to various theories on the subject, quoting largely from standard authors, and treating upon materialism and transcendentalism.

A very short discussion ensued.

## Ordinary Meeting, July 1, 1879.

Professor R. Tate, F.G.S., President, in the chair.

The Hon. Secretary laid upon the table—

"Entomological Society's Transactions," New South Wales.

"Proceedings of the Linnean Society," New South Wales.

"Proceedings of the Numismatic and Antiquarian Society," Philadelphia.

"Native Plants of Victoria Succinctly Described," by Baron Ferdinand von Mueller.

"Observations at the Adelaide Observatory for 1878."

In asking for the usual vote of thanks, Professor Tate remarked upon the great value of such works.

The Hon. Secretary read a letter from the Secretary of the South Australian Institute, stating that the Government had agreed to recommend that a subsidy of pound for pound upon the subscriptions to this Society should be appropriated from the sum granted to Institute.

The Hon. Secretary read a reply from the Adelaide University to a recommendation forwarded by the Philosophical Society on January 7, 1879. Whilst acknowledging the importance of the subject indicated in the recommendation referred to, and viewing with pleasure the fact that the Hon. B. T. Finniss and Professor Tate entertained the opinion that a larger staff would not be required for the accomplishment of the Society's suggestion, the Council of the University requested that the "comparatively small number of subjects" might be specified which it was desired that the Council should add to its curriculum, as well as to be informed of the arrangements by which the Council could, without additional expenditure, provide the course of study which the Philosophical Society desired to see established.

The Hon. Secretary submitted a draft reply, to be sent to the University Council, as follows:—

"Adelaide Philosophical Society,
"July 1, 1879.

"To Wm. Barlow, Esq., Registrar of the
Adelaide University.

"Sir—Your letter of the 31st May, referring to the resolutions *re* a suggested course of study for the training of Mining Engineers, passed by the Adelaide Philosophical Society and forwarded to your Council on 17th January last, has been considered by the Society, and I am instructed to draw your attention to the following points:—

"1. The Society did not affirm that the desired object—viz., 'the intelligent application of science to the processes of seeking, raising, and treating the ores'—could be attained without any additional expenditure, but suggested that, 'as the curriculum of the University already comprised several branches of knowledge bearing upon this subject, 'the Council might, by the addition of a comparatively small number of subjects, arrange for a course of study which would greatly advance the object sought, and would, by giving prominence to the importance of the subject, pave the way for a more comprehensive scheme.'

"2. The branches of study specially needed for the training of the Mining Engineer, and already included in the University course, are as follow:—

(*a.*) Mathematics (pure), including geometry and trigonometry as far as the solution of triangles.

(*b.*) Mathematics (applied), including statics, hydrostatics, kinetics, and physics (especially heat).

(*c.*) Mineralogy.

(*d.*) Geology.

(*e.*) Chemistry, including the classifications and characters of metals, and the chief applications of chemistry in the arts and manufactures.

(*f.*) Practical chemistry, including the analysis of ores.

"3. The additional branches of study, which, in the opinion of the Philosophical Society, should supplement the above are as follow:—

(*g.*) The application of (*a.*) to mechanical drawing and surveying.

(*h*) The application of (*b*) to the methods of mining and to the mechanics of the steam-engine and pumping and dressing machinery.

"4. It will be seen that the extra subjects are comparatively few in number, and consist in the practical application of subjects already taught.

"They are for the most part comprised in the course of training defined in the University calendar for candidates for the Angas Engineering Scholarship, who have (under clause 4 of the regulations) to pass an examination in mechanics and drawing, and such other subjects as the Council of the University shall from time to time direct, and must (under clause 6) have passed, to the satisfaction of the Council of the University, through such courses of special studies and practical training as shall from time to time be prescribed by the statutes or regulations of the University."

Reply approved.

The President read portion of a private letter which he had received from the Hon. L. Macleay, of Sydney, in which he stated that he approved highly of a suggestion made by Professor Tate that a congress of science workers should be held during the International Exhibition, and that annual meetings might be arranged for in the various colonies on the principle of the British Association. He would prefer the Association to include all the sciences coming under the term natural history, grouped as follows:—First section, anthropology, ethnology, and philology; second section, zoology and botany; third section, geology, geography, and meteorology; fourth section, medical science. He hoped that Professor Tate would be present in Sydney to assist at the opening of the Exhibition and to originate and organise the "Australian Association for the Promotion of Science."

A short discussion ensued, during which comparisons were instituted between the various colonies in the matter of scentific inquiry, and in which New South Wales and New Zealand were very favourably mentioned.

The President, with respect to objects and drawings shown at the Society's meetings, expressed the opinion that the exhibitor had a sort of copyright over them, and without his consent they should not be made public. He mentioned a letter which accompanied some drawings of butterflies, in which the exhibitor asked that they might not be copied, and remarked that it would be a breach of etiquette to copy such drawings without the consent of the contributor. He then placed the drawings alluded to upon the table, as well as some fossils received from Mr. J. G. O. Tepper, of Ardrossan, amongst the latter being the head of a Tribolite *(Olenus)*, which Professor Tate pronounced to be an undoubted evidence of the Lower Silurian origin of the rock from which it was taken.

The HON. SECRETARY read a paper entitled "A Census of the Insect Fauna of South Australia," by O. Tepper (see page 33).

A discussion followed, during which Professor TATE said Mr. Tepper had shown wonderful industry and observation in his researches, and had made himself acquainted with the habits of the insects in a way that showed how entomology could be made of practical benefit. A good many people looked upon beetle and butterfly collecting as a ridiculous pursuit, on a par with the accumulation of old china; but when timber gets destroyed and other ravages were committed the knowledge of the entomologist was sought for as valuable. Reference was also made by members to various insects from abroad which had become acclimatised, amongst which was the curculio (*Otiorhynchus meridionalis* ?) attacking the bark, leaves, and tender shoots of shrubs and trees.

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ORDINARY MEETING, AUGUST 5, 1879.

Professor R. TATE, F.G.S., President, in the chair.

Baron Ferdinand von Mueller, K.C.M.G., F.R.S., &c., and George French Angas, F.L.S., Corr. Memb. Zool. Soc., were elected honorary members.

William Russell, of Port Adelaide, was elected an ordinary member.

The HON. SECRETARY read a letter from the Committee of Council of Adelaide University, in answer to letter from the Adelaide Philosophical Society of July 1, 1879, *re* mining engineering, reiterating the opinion that the proposed addition to the curriculum would entail an expense which the University Council would not be justified at present in incurring. He also stated that an acknowledgment of its receipt had been forwarded.

Professor TATE gave notice of motion for next meeting, as follows:—"That in the event of the Board of Governors of the Institute being called upon to decide upon the question of opening the Museum on Sunday afternoons, this Society requests its representative to vote in favor of throwing open the Museum on Sundays."

Mr. T. Cloud, of Wallaroo Smelting Works, produced a number of specimens of wash-dirt from the Bingara diamond field of New South Wales, given him by Mr. A. Liversedge, Professor of Geology and Mineralogy, University of Sydney. He stated that they were specimens of bed-rock, upon which drift occurred. The drift was only a few feet in depth, and was represented in different parts of the district by the specimens laid on the table. The process of extracting seemed to consist of putting the stuff in a machine to separate the clay and small pebbles, and the diamonds were separated by one of Hunt's diamond machines. The gems, stones, &c., accompanying the diamond were tourmaline, or jet stone, occurring as rolled prisms; zircon; sapphire, generally in small angular pieces, usually of a pale colour; topaz, in rounded fragments; garnet, in small rough ill-formed crystals; spinelle, not common; quartz, in small prisms; brookite, very rare; titaniferous iron, common; magnetic iron in small prisms; wood tin, rare; gold and osmiridium, rare. The diamonds were small, some clear, colourless, and transparent, others a pale straw colour. One or two very small dark ones were found, also some of a greenish hue.

Mr. Cloud also produced a piece of atacamite found in the flues of the Wallaroo Smelting Works. (See p. 80.) He also showed a double sulphide of copper and iron crystallised, corresponding in chemical constitution and crystalline character with the natural product (Borell) which had been found in the copper furnaces.

The Rev. J. E. T. Woods' paper on "Australian Starfishes" was taken as read. (See page 89.)

Dr. J. F. Joyce read a paper on "Sunstroke," in which he explained the various symptoms attending an attack, and recommended several simple remedies, as well as precautionary measures, such as avoidance of exposure to the sun, abstinence from alcoholic liquors, and the use of a damp cloth in the hat when working in the sun.

Dr. S. J. Magarey mentioned the fact that decomposition set in very rapidly in cases where death resulted from sunstroke.

Professor Tate remarked that a confirmation of Dr. Magarey's statement existed in the fact that collectors, who frequently killed animals by tying them in the sun with their heads immovable, were compelled to remove the skins speedily, as decomposition soon ensued.

Mr. Ebenezer Cooke, M.P., read a paper "On the Museums in Australia and New Zealand," in which he pointed out the value of such institutions in creating a refined taste in all classes, exciting the interest of youth, extending their knowledge, and directing their studies. He also expatiated upon the splendid Museums of different cities in the world, contrasted them with that of South Australia, and condemned the comparative indifference to intellectual cultivation therein indicated. He described the Sydney Museum, its extensive collections, and the varied character of its contents; also the magnificent Melbourne Museum, which he said was about six times as large as ours, and held within its walls almost every form of creation. In addition to that was the Technological Museum, containing a vast number of samples of stone, woods, manufactured and raw material of every kind, shells, models of machinery, and products of all sorts, whereby men of every class, trade, or calling could find something to instruct or amuse them. The attendance on last Easter Monday was 8,000, and he questioned whether our Museum attracted 1,000 on that day. In answer to the oft-repeated argument that it was not fair to compare our colony with its more wealthy neighbour, he instanced the Museums of the smaller colonies of Queensland and New Zealand, which all exceeded ours in every way. He closed by referring to his own action in Parliament with respect to the Museum, and expressed himself strongly on the subject of making proper provision. The past, he said, had been so barren of results, and the future seemed so intangible, that the matter should be taken up without delay. The other colonies were very far in advance of us; collections of great value were being lost to us, on account of people who could give specimens to the Museum becoming disgusted and discouraged; the specimens already in our possession were many of them stowed away for want of room; the present space was so limited that immediate enlargement was necessary, and there were other potent reasons why something should be done in the way of providing a Museum worthy of the reputation and importance of the colony. He mentioned instances where valuable historical collections had been lost to Adelaide for want of a place to put them in; and after expatiating upon their importance, expressed the opinion that if the Museum had been put under a distinct Board of Governors it would have attained a degree of importance far above that which it at present occupied. In respect to the proposed new Institute building, he remarked that the Museum even then would not by any means compare in size with that of the crowded one in Christchurch. The Museum, he thought, might be connected with the Botanic Garden. In the past we had been always going to do something great, and never did it, and now we were so blinded with the brilliancy of what we were going to do that we were still doing nothing, and he desired to urge the necessity of some action in the interests of the community at large.

Mr. Magarey pointed out that the Tasmanian Museum was thirty years older than ours; the building was put up economically; and in Sydney the fine structure was obtained under favourable circumstances. In New Zealand the Museum was not an expensive one He believed that the one in Christchurch was of wood.

Mr. Cooke said he thought that those of Christchurch and Dunedin were of stone.

Mr. Magarey said Mr. Cooke's arguments were sufficiently good to stand without his making unfavourable comparisons.

Professor Tate referred the meeting to his own remarks on a former occasion when he dealt with the question of the value of Museums, and that of our Museum not fulfilling its proper functions—víz., in the way of accommodation and in other respects. The Museum might be in connection with the University. The Curator was hampered, and had not the liberty of buying on his own responsibility good specimens which were often placed in his way. The Council of the University were liberal to him (Professor Tate), and he trusted that the Museum connected with the University would be one which the colony could be proud of; he intended to do his utmost to make it so. New Zealand as a scientific colony ranked high, and had a foremost place amongst the British colonies. The scientific men connected with it were of world-wide reputation.

Mr. Chapple suggested that some temporary building might be provided, so that collections might not be lost. The matter was very pressing, and something should be done, even if it were only to put up a weatherboard building for the exhibition of valuable specimens.

Professor Tate remarked that the tendency here appeared to be to spend all the money on the outside and starve the interior. If £20,000 were put at the disposal of some practical gentlemen they would put up a building that would last 100 years and serve its purpose well.

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## Ordinary Meeting, September 2, 1879.

Professor R. Tate, President, in the chair.

The Hon. Secretary laid upon the table:—

"Observations at the Adelaide Observatory for December, 1878."

"Results of Observations in Meteorology, &c., in Melbourne." By R. J. Ellery, F.R.S. Vol. V.

"Eucalyptographia," first and second Decades. By Baron Ferdinand von Mueller.

J. W. Billiatt was elected an ordinary member.

Dr. Gosse said that this being the first occasion on which he had been enabled to attend the meetings of the Society since the delivery of the President's inaugural address in October last, he wished to correct a few errors into which the Professor had probably been inadvertently led, and which he was sure the Professor would correct as soon as he was convinced of his error. The first was with respect to the space which would be available for Museum purposes in the proposed new Institute building, which, instead of being inferior in area to that at present possessed by the Museum, would be greatly increased. The second point was with regard to the management, which the Professor had found fault with, but he directed attention to the annual reports, in which the requirements of the Museum had been urged without ceasing.

Mr. R. Rees supported the remarks made by Dr. Gosse in a lengthy speech, in which he mentioned that the space devoted to the Museum in the new building would be 200 feet long by 55 feet wide and 44 feet high.

Mr. C. Todd, C.M.G., supported, stating that with respect to the purchase of specimens the Governors had never opposed any purchases recommended by the Curator. He mentioned the entomological collection made by the late Mr. Odewahn, of Gawler, and stated that it was not purchased because it had been reported upon by the Curator as not being of any great value to the Museum.

Professor Tate admitted that he might have been misled as to the space available for the Museum, but asked if the whole of the space mentioned by the previous speakers would be at once placed at the disposal of the Curator, or whether it was not the fact that a small portion only would be set apart, and the remainder of the accommodation relegated to the distant future, when the whole of the proposed building should be completed? He had made no attack upon the governing body of the Institute, but only spoke in the interests of the Museum, and really addressed his remarks to the Government and to the public. He considered the specimens in the Museum were badly displayed, and possessed no educational value; but he had not asserted that the Museum was badly managed. His aim had been to show that there had not been such a display of the specimens as might have been wished, even with the space available. He denied that the public could derive instruction, and as a professional Curator he stated that they could be better arranged. He mentioned the fact that there was no mineralogical collection available for transmission to the Sydney Exhibition, and that collectors were now engaged in the work of gathering specimens.

Dr. Gosse said, with respect to a diamond mentioned by

Professor Tate as having been offered to the Museum for £8, that no such offer had been made to the Governors.

Canon FARR rose to supplement the observations made by the previous speaker, but was checked by the President after making a few remarks, in which he stated that the space available in the first section of the new building would be 70 x 40 feet, with a gallery 156 feet long, giving a total area of 4,672 feet.

Dr. MAGAREY characterised the discussion as irregular and against the rules. He said that it was undignified for four of the Governors to take up the time of the meeting in attacking the President. The Philosophical Society was not bound by the opinions and utterances of its President. He thought the Professor's remarks would do more good for the Museum than anything the Governors had ever done, and that they might justly claim him as being on their side.

Professor TATE said he had allowed the discussion to proceed, although very irregular, because if he had checked it it might have been thought that he was desirous of escaping any censure which might be considered to be levelled at him.

After a few further remarks the discussion closed.

In the absence of the Hon. Secretary, Mr. THOS. D. SMEATON read "A Census of South Australian Insects. Part II." By J. G. O. Tepper (see page 33).

Professor TATE read a paper on "The Newer Tertiaries of Munno Para, and the Water-bearing Capabilities of the Adelaide Plains." By Gavin D. Scoular (see p. 60).

The following papers were taken as read :—

"Recent and Fossil Species of Australian Salenariadæ." By J. E. T. Woods.*

"Zoologica et Palæontologica Miscellanea." By Prof. R. Tate. (See page 129.)

"Note on the Artificial Formation of Atacamite." By J. T. Cloud. (See page 80.)

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## ANNUAL MEETING, OCTOBER 7, 1879.

Professor R. TATE, F.G.S., President, in the chair.

The HON. SECRETARY laid upon the table—"South Australian Aboriginal Folk-lore," from the MSS. of the late Rev. G. Taplin, published by the Government of South Australia; "Meteorological Observations of the Summer, Winter, and Spring of 1878-9, taken in England," by C. L. Wragge, F.R.G.S.

Professor TATE read his President's annual address on "Outlines of South Australian Geology." (See page xxxix.)

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* The publication of this paper is unavoidably postponed.

The Hon. Secretary read the Annual Report and Balance-sheet. (See page xxxvi.)

The following gentlemen were elected as officers and Council for the ensuing year:—

President—Professor R. Tate, F.G.S.

Vice-Presidents—Chas. Todd, C.M.G., F.R.A.S., M.S.T.E., and Fredk. Chapple, B.A., B.Sc.

Hon. Treasurer—Thos. D. Smeaton.

Hon. Secretary—Walter Rutt, C.E.

Council (in addition to above)—J. C. Verco, M.D.; S. J. Magarey, M.B.; D. B. Adamson, R. Hickson, M.I.C.E.

Votes of thanks were accorded to the officers for the past year.

# REPORT OF THE COUNCIL

OF THE

# ADELAIDE PHILOSOPHICAL SOCIETY,

## For the Year ending September 30th, 1879.

The Council has the satisfaction of stating that the useful work of the past year is at least equal to that recorded of any previous year in its history.

The following papers were laid before the Society during the year:—"Our Climate and Infant Mortality," by S. J. Magarey, M.B.; "The Philosophy of Consciousness," by Hon. B. T. Finniss; "The Aborigines of South Australia," by J. D. Woods; "Statistics of Consumption in South Australia," by J. C. Verco, M.D.; "The Rocks and Cliffs at Ardrossan," by O. Tepper; "The Physical Features and Natural History of the Country around the Great Bight," by Prof. Ralph Tate, F.G.S.; "Will: the Effect of Physical Forces acting on the Brain," by Hon. B. T. Finniss; "Census of the Insect Fauna of South Australia, Part I," by O. Tepper; "List of Australian Star-fishes," by Rev. J. E. T. Woods, F.L.S., F.G.S., &c.; "Sunstroke," by J. F. Joyce, M.D.; "Museums in Australia and New Zealand," by E. Cooke, M.P.; "Census of the Insect Fauna of South Australia, Part II," by O. Tepper; "The Newer Tertiaries of Munno Para," by Gavin Scoular; "Recent and Fossil Species of Australian Salenariadæ," by Rev. J. E. T. Woods, F.L.S., F.G.S., &c.; "Zoologica et Palæontologica Miscellanea," by Prof. Ralph Tate, F.G.S.; "Note on the Artificial Formation of Atacamite," by J. F. Cloud, F.C.S.

The Council has felt that the Society was not obtaining from its affiliation to the South Australian Institute all the advantages which had been intended by the Legislature to attend such a connection, and has represented to the Government that although the Institute Act provides that the affiliated Societies may share in the moneys provided for Institute purposes by the annual vote of Parliament, the estimates were worded in such a manner that they were precluded from the enjoyment of this privilege. The Government has acknowledged the justice of the representation, and the wording of the estimates, as passed this session, places the affiliated Societies on the same footing as country Institutes, the subscriptions to which are subsidised by the Government at the rate of pound per pound. The augmented income which will result from this decision will enable the Council to fulfil the hope expressed in their last report, and to publish the transactions and proceedings annually, and in a more complete form than was possible in the volume for 1877-78. The transactions, being forwarded to the leading scientific Societies of the world, afford an opportunity of putting before students facts in connection with the natural history of this Province, which, though very valuable, would otherwise be lost. The Council therefore urges upon all the members that they should place upon record their own observations and such as may come under their notice by communicating them in the form of papers or memoranda to the Society. A correspondence has taken place between the Society and the Council of the Adelaide University, in which the Society urged upon the Council the advisableness of adding to the University curriculum lectures upon the practical application to the profession of mining engineering, of the subjects already included in the course of study as laid down in the University Calendar, with the object of inducing the more scientific, and therefore the more economic, development of the mineral resources of the Province. The University Council has acknowledged the importance of the subject, but, after a long consideration of the Society's suggestions, has come to the conclusion that financial considerations must prevent any steps being taken in this direction at present. Death has again removed from our midst one of our oldest members. Mr. Benjamin Herschel Babbage, C.E., may almost be considered to have been one of the founders of the Society, having joined it on 17th January, 1853, one week after its formation. He has throughout taken a deep interest in the Society's work, and has several times held the office of Vice-President. There has been during the year an increase of six in the membership of the Society. This is a matter for congratulation, but the Council feel that there are many gentlemen in the Province who are interested in the progress of science, and who might materially advance the same by connecting themselves with this Society, whose names do not appear on our roll. They also regret that only two young men, and no ladies, have availed themselves of the advantages held out by the recently adopted rule forming the class of associates. In conclusion, the Council expressed a hope that their successors may receive the support of every member, and that the progress which has characterised the Society during the last two years may continued in the future.

## THE TREASURER IN ACCOUNT CURRENT WITH THE ADELAIDE PHILOSOPHICAL SOCIETY.

| Dr | £ | s. | d. |
|---|---|---|---|
| October, 1878. | | | |
| To Balance ... ... ... ... | 124 | 15 | 2 |
| Subscriptions ... ... ... ... | 118 | 2 | 0 |
| Transactions and extra copies of Papers sold... | 2 | 5 | 0 |
| | £245 | 2 | 2 |
| Balance brought down ... ... ... | £127 | 15 | 7 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| By Contribution to S. A. Institute ... ... | 12 | 0 | 0 |
| Printing Transactions ... ... ... | 55 | 13 | 0 |
| Do. Circulars ... ... ... | 11 | 12 | 6 |
| Advertising ... ... ... ... | 13 | 13 | 0 |
| Postage and Sundries ... ... ... | 4 | 2 | 10 |
| Commission collecting Subscriptions ... | 5 | 11 | 3 |
| Assistant Secretary's Salary ... ... | 12 | 12 | 0 |
| Do., sending out Transactions ... ... | 2 | 2 | 0 |
| Balance ... ... ... ... | 127 | 15 | 7 |
| | £245 | 2 | 2 |

Audited and found correct,

4th October, 1879.

E. PARISS NESBIT,
Auditor.

THOMAS D. SMEATON.
Treasurer.

# The Anniversary Address of the President,

Professor Ralph Tate, Assoc. Lin. Soc., F.G.S.

Prefatory.—At our last Anniversary, when I had the honour of addressing you from this chair, I took occasion to sketch the present state of our knowledge of the Natural History of South Australia. But as that retrospect does not embrace Geology, beyond indicating the chief published sources of our information, and directing attention to the salient points of our geology about which accurate observations are needed, I propose, now, to supply the omission. I shall, however, pursue a somewhat different plan in dealing with the Geology than I did with the other branches of Natural History, and instead of a mere review of what has been published on the subject, I will incorporate all the information that I have acquired by personal observation and by correspondence with what has been written. In this endeavour I hope to present you with a more systematic and fairly comprehensive history of the geological changes that this land of ours has undergone than it would otherwise be possible. An attempt of the kind was made by me in a course of lectures on "The Ancient Physical Geography and Geology of South Australia," delivered during the winter of 1877 under the auspices of the University of Adelaide.

The following Syllabus is a reprint, as advertised :—

Lecture I.—April 9th.

Educational value and objects of Geological Science.

Geological preliminaries, embracing the origin and phenomena of igneous and sedimentary rocks, and the classification of sedimentary rocks.

Surface features of South Australia. Coast scenery, and its relation to rock structure.

Lecture II.—April 16th.

The origin and characteristics of our shingle beaches and sand dunes—The Coorong and Murray bar.

Nature and origin of alluvial plains. The Biscuit Flat and its characteristics.

Lecture III.—April 23rd.

South Australia slowly rising : its ancient sea margins. Raised beaches of Victor Harbour, Aldinga, Brighton, Yorke's Peninsula, &c. Recent marine limestone and other deposits of Dry Creek, Glenelg, Edithburgh, Victor Harbour, Lacepede Bay, &c. Contemporaneous sandhills of Plympton, Alberton, and Cape Northumberland.

Distribution of marine life in depth.

Lecture IV.—April 30th.

The plains of Adelaide, Willunga, &c., the beds of deserted lakes. General character of their deposits, and of the auriferous drifts. Are we drying up? The erosive action of rivers; the recession of the Wannon Falls. The origin of the gorge of the River Murray, and proofs of a former lake-expansion of the Murray waters over the Murray plateau.

Nature and origin of the white limestone of Adelaide.

Lecture V.—May 7th.

The origin of our salt lagoons and of the brackish waters of our wells. Lake Torrens—an arm of Spencer's Gulf, or a salt lagoon? Underground drainage in the South-Eastern Districts. The Adelaide hills once enveloped in perpetual snow: the ice-worn aspect, and other evidences of glacial action. Ice-borne granitic blocks on Yorke's Peninsula; ice scratches in the valley of the Inman.

Lecture VI.—May 14th.

The extinct gigantic animals of the Pliocene period, and their relationship to the existing fauna.

Retrospect. The subsequent climatic changes which gave rise to the present order of things. The extinction of the large animals.

The volcanoes of the South-east; proofs of their comparative recentness. Distribution of volcanic material beyond the present volcanic centres.

Lectures VII. and VIII.—May 21st and May 28th.

South Australia an archipelago during the Miocene period. The rocks of the period, as exhibited in the cliffs of Aldinga Bay, Yorke's Peninsula, the River Murray, &c. The origin of the sediments constituting the same.

The littoral character of the deposits at Gawler, Morphett Vale, Lake Torrens, &c.

The semi-tropical character of the marine productions of the period—colossal sharks, carnivorous whales, &c. The relation of the fauna to recent and past periods.

Deep-sea soundings, and life off the Australian shores.

Lecture IX.—June 18th.

Jurassic formation of the interior.

The geological structure of the Adelaide hills; two distinct sets of strata—the older and metalliferous, the younger and non-metalliferous. The ancient volcanoes of the Adelaide hills, and their association with the gold and copper bearing rocks.

Lecture X.—June 25th.

On the probable presence of true coal in South Australia; and on the relative ages of true coal and lignites. Nature and origin of the substance called "Coorongite."

As most of the facts, then communicated, were chiefly acquired by personal observation, extending over the brief period of fifteen months, I doubted whether my generalizations about such a vast and unexplored region as South Australia would not require considerable modification as the result of more extended observation. This fear restrained me from publishing the lectures; but having greatly extended the area of observation, and having been assisted by other workers, in the interval of more than two years, which has elapsed since the delivery of the lectures, I present you with more confidence these "Outlines of South Australian Geology," which are, however, based on them. The interest that is shown for the subject will justify the issue of the "Outlines," despite that imperfection which inevitably belongs to it as a pioneer work. To conclude these introductory remarks, I may state that the field of unexplored facts is so vast that there is ample room for an army of workers, acting independently and for many years to come. If amateurs would only give to the Society what they know of the geology of particular localities in their neighbourhood, we should make a great advance towards a complete geological history of the colony. I owe to not a few in the Far North, on the Murray, in the South-East, and elsewhere hearty thanks for their active co-operation in my geological investigations, and for the promise of future help. That there are men, who are not altogether absorbed in money-getting, able and willing to add to our stock of knowledge, I have good reason for saying.

## LEADING PHYSICAL FEATURES OF SOUTH AUSTRALIA.

If we inspect the map of South Australia proper, we observe that the mountain ranges follow the general direction of the two Gulfs, St. Vincent's and Spencer. The elevated regions of the southern part of the Province occupy three well-defined areas, separated from each other by the gulfs mentioned; but in their northerly extension they approach each other, and to the north of Lake Torrens no well-defined mountain system obtains. Our ranges are rather of a composite character, consisting of parallel ridges, often separated by broad and deep plain-like valleys; this feature is most prominent to the north of Kooringa.

The first group is that of the Adelaide chain, which commences at Cape Jervis and occupies the coast line to the north as far as Normanville, and to the east as far as Port Elliot, and continues with varied height in a nearly north direction to beyond Lake Frome, a distance of 350 miles. It attains its greatest elevation in the Mount Lofty and Barossa districts, and its chief highest points are Mount Lofty, 2,334; Kaiserstuhl, 1,973; Lagoon Hill, 2,235; and north of Burra Burra, Mount Cone, 2,601; Razorback, 2,834. It is very little interrupted in its course, and that only by a few narrow gorges through which are discharged our insignificant rivers, emptying themselves into St. Vincent's Gulf. Two spurs are thrown off on its western side within our immediate district, one terminating in the sea cliffs between Marino and Morphett Vale, and the second in those forming the southern boundary of Aldinga Bay.

The second group is that of the Flinder's Range, which commences in the elevated land of Northern Yorke's Peninsula, but more prominently in the conspicuous hills termed the Hummocks at the Head of St. Vincent's Gulf, thence it follows a curvilinear line with a general northerly direction to round the head of Lake Torrens. The east coast of Spencer's Gulf and Lake Torrens has the same general direction as this chain, and to which it is in close proximity; and also because of the small annual rainfall, about 12 inches, though the elevation of the range is higher than that of the Adelaide chain, the rivers are all short, and for the most part do not reach the sea or Lake Torrens. The highest points in this range are among the highest in South Australia. They are—the Bluff, 2,404; Mount Remarkable and Mount Brown, about 3,000 feet.

The third elevated region is that of Eyre's Peninsula, which does not seem to present any well-defined system. However, the Gawler Ranges, on its north, are represented on our maps as having an east and west strike; and the high grounds about Port Lincoln seem to have a north and south trend; but to the westward, certainly as far as Streaky Bay, the generally undulating country is dotted over by isolated peaks, or short razor-backed ridges showing no uniformity as to direction.

All these elevated regions are constituted of the fundamental rocks and their associated granites.

The Adelaide chain is bounded on its western side by the vast and fertile plain of Adelaide, which extends from Marino, on the south, and sweeps round the head of St. Vincent's Gulf on the north. No inconsiderable portion has been removed by the action of the sea, as it is abruptly terminated on the shores of Holdfast Bay and at Ardrossan on either side of the Gulf. The period of its formation is comparatively recent. Plains of a like character are interspersed in longitudinal bands among the parallel ridges of the Flinders Range and northern extension of the Adelaide chain, though not one is equal in magnitude to the Adelaide Plain. The two southern spurs of the Adelaide chain enclose undulating plains, in part partaking of the character of the Adelaide Plain, but mainly constituted of rocks of much older, though of Tertiary date; the northern one is the Willunga Plain, the southern is the Myponga Flat.

On the eastern side of the Adelaide chain there stretches far and wide the Plain of the South-East, towards the western boundary of which flows the Lower Murray. The dimensions of this plain are about 290 miles from north to south and an average of 100 miles from east to west. The general level, which is broken by low sandy ridges, does not exceed 200 feet. The rocks composing it are of the same age as those composing the Willunga Plain and the lower tracts of Yorke's Peninsula. The prevailing uniformity of scenery is relieved in two limited areas by isolated conical hills of granitic and of volcanic materials; and towards the seaward margin by immense swamps. No rivers originate in this plain, though a few short ones traverse its western margin in their passage from the Adelaide chain to the River Murray.

To the north and west from Lake Torrens there stretch almost unlimitable plains, somewhat similar in their character to portions of the S.E. Plain. The western section is probably coterminous with the Bunda Plateau, around the head of the Great Australian Bight.

Jukes (1846), Burr (1846), and other early geological observers recognised these leading surface features of the province, and relegated the strata of the hill ranges to the Palæozoic and metamorphic series, and the fossiliferous beds constituting the plains to the Tertiary epoch.

### Pre-Silurian.

Burr, occupying himself with the geological structure of the country between Mount Arden and the South coast, and eastwards of the meridian of Mount Arden, has given us a sketch of the sequence of the strata of these ranges. He notes their southerly dip, and considers them, probably, to correspond with the Cambrian and Skiddaw systems of Sedgwick, having been led to this belief from the circumstance of there being no fossils in them. In his generalised section of the arrangement of these old rocks he has not attempted to give thicknesses; and it appears to me that he has inverted the true order. In an ascending series he represents it as follows:—

1. Quartzose sandstone.
2. Dark-coloured slate.
3. Limestone beds, frequently very impure, and passing into
4. Slate and slaty beds (metalliferous).
5. Mica slate, chlorite slate, and thence frequently into sandstone (metalliferous).
6. Gneiss, which is metalliferous, resting on
7. Unstratified granite, and other igneous rocks.

The strata composing the principal range of South Australia have a general dip to the south-east, and show a succession of clay slate with quartzite bands, crystalline limestones, mica slate and other decidedly metamorphic rocks, and granite. It is remarkable that the apparently less metamorphosed strata occupy the lowest position, whilst the uppermost stratum is gneiss, unless we regard the granite, which follows next, in the light of the extreme of alteration of which the gneiss is an earlier phase. That the highly metamorphic rocks do not form the axis of the Adelaide chain is beyond dispute. And in various traverses across the strike of the strata of our hills I have failed to detect faults or inversion, which would account for their exceptional position, whilst, on the contrary, the successional arrangement is sufficiently clear to leave little room for question.

These rocks are the chief repositories of our mineral wealth, including ores of copper, lead, silver, bismuth, iron, and gold. They exhibit little disturbance, and the absence of faults is noteworthy; however, along the line of the anticline, from Hallett's Cove to the Stockade, and along the Gawler hills, well marked examples of highly contorted strata are to be seen.

Mr. Selwyn has given an approximate measure of the thickness of the strata in the Cape Jervis promontory between Normanville and Encounter Bay. He states that "the dip of the beds appears to be very regularly and constantly to the south-east, at an average angle of not less than 30 degrees, and consequently, unless some very extensive faults occur—of which I could see no evidence—there is a constantly ascending series, exposing a vertical thickness of nearly 30,000 feet of strata." In this connection Mr. Selwyn records an observation that is confirmatory of my opinion of the prevailing superposition of the mica slate and gneiss:—"From the *highly metamorphic character* of nearly the whole of these rocks, and particularly of *those portions that*, from the dips, would *appear to be the highest beds of the series*, it is often exceedingly difficult to determine whether the dip observed is really that of the beds, or only that of the cleavage." There cannot be a doubt that the thickness of these fundamental rocks is much greater in those portions of the central chain near Adelaide than in the Cape Jervis promontory; indeed, Mr. Scoular has led us to infer that 90,000 feet in vertical measure are displayed in the South Para river, and that this thickness is not a moiety of the whole; and I trust that our curiosity in this particular will soon be satisfied by the publication of an extended horizontal section from the Gawler Plains eastward, which, we know, our zealous corresponding member has long been engaged in preparing.

Mr. Selwyn was at first inclined to the opinion that the slaty rocks, which underlay unconformably the sandstones, purple and grey shales, and siliceo-calcareous beds which occupy the whole country from Mount Remarkable and Port Augusta, north-east of Mount Serle, belonged to a superior set of beds than those which occupy the whole of the country to the south; but he afterwards thought "it just possible that no such natural divisions exist in the rocks of the South Australian chain, and that the difference in general mineral and lithological characters observed between the northern and southern rocks is entirely due to metamorphic influence." In the absence of fossil evidence that geologist hesitates to express any opinion, either as to the probable age or even superposition of the various rock masses forming the central mountain chain of South Australia; but, nevertheless, has stated that "the only locality in which the rocks of that chain bear any decided resemblance in mineral and physical structure to the auriferous Silurian rocks of Victoria is in the valley of the Onkaparinga; and, consequently, I was at first inclined to suppose that all those rocks that are doubtless higher in the series—including the crystalline limestones of Finniss Vale, Macclesfield, Mount Torrens, Keyne's Hill, Angaston, and the Burra—were altogether newer than Silurian. Now, however, I am inclined to think that this view is probably erroneous, and that they are all true Silurian rocks. At all events the difference in mineral character is no greater than exists between the slaty lower Silurian rocks of Wales and the siliceous limestone, gneiss, and quartz rocks of the same formation in the Northern Highlands of Scotland. . . . I was much struck with the remarkable accordance in lithological character and general sequence of the siliceous limestones, quartz rocks, and micaceous flagstones of the Durness and Assynt Silurians, with that of the siliceous limestones, quartzose sandstones, and micaceous slates and flags of the northern part of the South Australian chain; and I have little doubt, though rare and not easily detected, that fossils will eventually be found in some portion of the latter, as they have been in the Durness and Assynt limestones, that will enable them to be at once assigned their true position in the geological scale."

According to the Rev. J. E. Tenison Woods (Geol. Obser. in S. A., pp. 20, 21) fossils have been found at two portions of the Adelaide chain—at Willunga thirty miles south, and at Nuriootpa, forty-seven miles north from Adelaide. At the former locality it was reported to him that *Pentamerus oblongus* had been found; but from the latter, a fossil which had been collected by his brother has been recognised by the Rev. J. E. T. Woods as *Cruziana cucurbita*—a species of algæ described from the Silurian rocks of Bolivia. Until the observation of the occurrence and identification of *Pentamerus oblongus* be verified it would be well to expunge it from our list of local fossils; indeed the Rev. Mr. Woods inclines to its rejection. And as the very nature of the fossil, *Cruziana cucurbita*, precludes it from being used as a test of geological age, I conclude that the Lower Silurian age of the rocks of the Adelaide chain is not proven. Indeed, recent discoveries, which have been communicated to this Society by Mr. Tepper, necessitate their relegation to a much more ancient epoch. The chief facts are—that in the neighbourhood of Ardrossan, a lower series of metamorphic slates and limestones is covered unconformably by fossiliferous limestones of the Lower Silurian epoch. And though the lower series underlying the fossiliferous limestones and associated strata about Ardrossan cannot be brought into direct relationship with the fundamental rocks on this side of St. Vincent's Gulf, yet their mineral character and sequence place them in accord. And the same may be said of the rocks constituting the high lands on Eyre's Peninsula.

Evidences of a missing chapter in the geological history of this province are afforded by the occurrence of rolled pebbles of stratified rocks in the oldest known of our sedimentary deposits. These are well-rounded quartzite pebbles, discovered by Mr. Scoular in the grit bands in the basal beds of the Gawler hills, and subangular pebbles of gneiss in the siliceous clay-slates at Hallett's Cove.

*Associated Eruptive Rocks.*—Though I have expressed the opinion that the great masses of granites, eurites, and syenites associated with the metamorphic strata of the Adelaide chain are probably altered sedimentary rocks, yet I do not wish it to be understood that all South Australian granites are to be included in that category. One undoubted dyke of granite is that which forms the headland of Rosetta Head, and Granite Island, and is continued to Port Elliot; its intrusive origin is obvious by the veins passing from it into the adjacent mica slate, fragments of which are also found entangled in it, and particularly by the circumstance that its course cuts directly across the line of strike of the mica slate and clay-slates. According to Mr. Burr, a similar granite is visible above water at Cape Jaffa and at Cape Morard de Galles.

Granite dykes of small dimensions, but numerous, traverse the sandstones and metamorphic rocks as you approach the extensive granite area at Palmer from the west; but the two rocks are mineralogically very different.

Intrusive rocks are, however, infrequent in the Adelaide chain; Mr. Selwyn noticed felspathic granite at Mount Bryant. In the Flinders Range he observed a small greenstone dyke on the east flank of Mount Remarkable, and Mr. Ulrich has described dioritic dykes at three other places in the Flinders Range to the north of Port Augusta.

## Lower Silurian Rocks.

Mr. Selwyn describes the whole of the country from Mount Remarkable and Port Augusta, north-east of Mount Serle, as occupied by sandstones, purple and grey shales, and siliceo-calcareous beds resting unconformably on the more slaty series which covers the surface to the southward. This unconformity is illustrated by a sketch section of Mount Remarkable, the description of which runs as follows:—" At Mount Remarkable a soft aluminous stone of reddish white, pink, and brown tints is used for building. Immediately to the west of the village these beds are dipping 85 degrees to the westward, and are overlaid by soft red gritty quartzose sandstones; and towards the summit of the Mount thick bedded quartzose sandstones and siliceous freestones dipping at about 15 or 25 degrees to the westward."

These beds occur in great anticlinal and synclinal undulations, such as is seen in the singular and picturesque Pound Ranges at Wilpena and Warraweena. Their sequence, as determined by Mr. Selwyn, is as follows, in descending order:—

1. The upper quartzose sandstone and quartz rock series, which, commencing with the summit of Mount Remarkable, extends through all the peculiar flat-topped and tent-shaped hills west of Port Augusta, and forms generally the summits of all the higher peaks and ranges as far north as Mount Serle.

2. The hard fine-grained and micaceous green, grey, and purple slate, sandstone, and flag series underlying the above, as seen in the Flinders Range at Horrock's Pass, and in Elder's and Chase's Range, and on the west side of Spencer's Gulf.

3. The siliceo-calcareous series, forming the axis of the great anticline at Arqueba, and at Angorigina, Appealina, and Oratunga.

4. The dark blue fine-grained arenaceous flags and sandstones of Appealina.

We need to place in this group of strata the coarse siliceous sandstones that form the higher portions of the Mount Lofty Ranges, which Mr. Selwyn considered as part of an upper unconformable formation. From a cursory examination I was led to form the same opinion, and estimated the thickness of the unconformable beds on Mount Lofty at 700 feet. The extent of the coarse sandstones is fairly well defined by the forest of the Stringybark Eucalyptus.

No trace of organic remains had been found by Mr. Selwyn, "unless, indeed," he writes, "the peculiar circular and oval shaped markings in the quartzose sandstones west of Port Augusta are annelide tracks."

Strong presumptive evidence of the fossiliferous nature of some of the rocks which occupy the surface of the Northern Areas is afforded by the following observation:—I have in my possession an ovoid stone, such as is used by the aborigines for pounding *nardoo* seeds. It was picked up by Mr. Gipps (then on the Ordnance Survey) in the Lake Torrens district, who noticing traces of fossils on the exterior broke it across, and thereby happily displayed several well preserved specimens of

*Orthis calligramma*, a characteristic Lower Silurian fossil. The matrix is a calciferous sandstone of a grey colour.

Though Mr. Selwyn has not assigned the upper unconformable series to any geological epoch, yet he leads us to infer the probability of its belonging to the Devonian period. Another geologist, Mr. Ulrich, who has had opportunities for forming an opinion upon the successional order in the rocks to the north from Port Augusta, does not fully confirm the observations of Mr. Selwyn. He says, "I agree with him, for the same reasons he advanced, in unhesitatingly assigning them to one of the older epochs of the Palæozoic period—the Lower Silurian being perhaps the most likely one. Owing, probably, to my rapid mode of travelling, I was not able, however, to recognise the features upon which Mr. Selwyn based their subdivision into older and newer; for, throughout the country traversed, from the Burra northward, I saw no evidence of any unconformity in the strata; they seemed to me to represent one and the same grand series, only in places more or less metamorphosed by contact with intrusive rocks." (Mineral Resources north of Port Augusta, Parl. Rep., p. 18).

The discoveries made by Mr. Tepper, and referred to on p. xlv. confirm Mr. Selwyn's opinion that our Palæozoic rocks belong to widely separate periods; but they, at the same time, necessitate an alteration in the terms by which they have been designated. The fossils, which have been obtained from the thick "Parara" limestone, overlying mica slate, marbles, &c. (see Tepper's paper, Phil. Soc., Adelaide, p. 71), consist chiefly of heads and other fragments of a species of blind trilobite, probably an *Olenus;* but other forms observed are several examples of a small species of *Ecculiomphalus*, a *Capulus*, slender conical casts of an *Orthoceras* or *Creseis*, and fragments of corals (some of which showing a cystiphylloid structure). That we have herein a Silurian facies is not likely to be questioned; but to what group of the Lower Palœozoic rocks should the limestones yielding the fossils be referred, is a question that had better be reserved till more tangible evidence is forthcoming. That we are on the eve of a great discovery, so far as concerns the classification of South Australian Primary rocks, must be conceded.

## MESOZOIC.

Jurassic.—The Rev. W. B. Clarke, in his "Sedimentary Formations of New South Wales," p. 84, does not credit South Australia with the possession of Mesozoic rocks, fossiliferous evidence of which had been publicly made known previous to the publication of that work. He had evidently overlooked the very brief announcement made by me, Quart. Journ. Geol. Soc., p. 258, 1877, that *Belemnites* allied to *B. australis*, Phillips, and other Jurassic fossils occurred at Stuart's Creek; and had lost sight of the fact that Mr. C. Moore, Quart. Journ. Geol. Soc., 1870, records the existence of a Jurassic fossil of Queensland, *Cytherea Clarkei*, Moore, on the Gregory, north of Finniss Springs.

The history of the discovery of Mesozoic fossils at opposite extremities of the continent will be found in the papers by Mr. Moore, *op. cit.*, and Mr. Daintree, same journal, 1872. The Jurassic fossils from Queensland are referred to 89 species, not one of which is, with certainty, identical with European forms, whilst those from West Australia, which belong to 30 determined species, are for the most part of European origin. It is also noteworthy that there are no species in common to the two Australian areas. The distinctness of the faunas renders it highly probable that widely separated periods are represented by them, and I am strongly of opinion that the Queensland type approximates to a Cretaceous facies. However, there are no decided points of contact between the marine faunas of the Jurassic and Cretaceous periods of Queensland.

The South Australian localities affording Jurassic fossils are in the interior and on the line of the transcontinental telegraph; the more distant locality is the Peake, 700 miles from Adelaide; the nearer one is Stuart's Creek, where Stuart found the species of *Cytherea*, first mentioned by Clarke, and subsequently named by Moore *C. Clarkei*. Mr. F. G. Waterhouse, in his report "On the Features and Productions of Country on Stuart's Track across Australia," records the discovery in the following terms:—"I was fortunate to find in the vicinity of the Gregory and the Welcome Springs, in small portions of argillaceous rock, which here and there crop out on the surface of the plain, some fossil wood and shells. The shells are marine, and consist of mussels and three other species of bivalves. I am not able at present to ascertain whether these fossil shells are identical with the recent ones found on our coasts, but I am inclined to think they are not. I hope at some future time to be able to decide this, as it would throw much light on the geological formation of this part of the country by showing to which of the divisions of the Tertiary formation this argillaceous rock belonged" (p. 2.) Seventeen years have elapsed since the above observations were made, and so far as I can ascertain the inquiry has not advanced one iota. An examination of the specimens has proved that they belong to species forming part of the small Jurassic fauna made known to me through the collections forwarded by Mr. Canham, of Stuart's Creek, The following notices of fossiliferous rocks, made by Mr. Waterhouse, doubtlessly refer to the same formation:—"Near the base of Mount Beresford I found in some detached portions of an argillaceous rock some fossil marine mussel shells." And again, they "were kind enough to collect for me some valuable fossils from the vicinity of Mount Margaret." From the vicinity of the Peake I have received from Mr. Canham Belemnites and other Jurassic species identical with those at Stuart's Creek.

Of the fossils which admit of specific determination, five occur in Queensland, whilst one only is referable to a Western Australian species.

*List of Jurassic Fossils from Central Australia.*

Belemnites australis, Phillips.
Belemnites Canhami, Tate *(m.s.)*
Natica variabilis, Moore.
Monotis Barklyi, Moore.
Modiola unica, Moore.
Modiola sp.
Cytherea Clarkei, Moore.
Cytherea, or Chione spp., in casts.
Rhynchonella variabilis, Moore.

Cretaceous.—The Cretaceous rocks occupy in Queensland, at a rough approximation, 200,000 square miles, for the most part good pastoral land. They present the physical aspect of vast plains stretching westward from the main dividing range to about the meridian of Central Mount Stuart. That this portion of the Mesozoic system extends throughout the whole of Central Australia is more than probable, hidden, however, over large areas by the "Desert Sandstone."

Though we have no internal evidence of the existence of Cretaceous strata in this province, yet as those of Central Queensland have been traced up to our boundary by Mr. Daintree, it can only be a question of time that is involved in substituting the presumptive by the positive.

*Mineral Springs.*—There is one subject of practical interest connected with the distribution of the Jurassic rocks, and that is the occurrence of hot mineral springs, which suggest the probability of obtaining supplies of water on the Artesian principle over some portions at least of the Mesozoic plains, and possibly over those portions covered by the "Desert Sandstone."

These springs are situated around the southern and western shores of Lake Eyre, and as they flow to the surface of an open level plain in an arid climate they are doubtlessly natural artesian wells. Some writers have attributed to them a volcanic origin, from the circumstance that from their overflow a crater-like mound of sinter has been deposited.

One of the Primrose springs on the Neales River has a temperature of 108 degrees, and others of them are hot and cold. The description of Blanche Cup Springs by Mr. F. G. Waterhouse will serve as a type:—"This is the most beautiful *volcanic* cone I have seen. It rises about the height of from thirty to forty feet, and the cup or crater at the top is about forty feet in diameter, and is filled with fine limpid water encircled with fine tall green reeds. This *lava* is of a very hard and compact nature, of a grey colour, and much resembles *siliceous limestone.*"

### Older Tertiary.

The older Tertiary deposits of undoubtedly marine origin occupy three basins, which are not now coterminous. They are:—

1. The Murray basin. 2. That of Aldinga and Southern Yorke's Peninsula; and 3.That of Bunda, Great Australian Bight.

The Murray basin is the most extensive, and embraces nearly the whole of the country in South Australia to the east and south of the River Murray, and, moreover, a considerable tract resting on the west and north bank of that portion of the river within our territory.

The strata, which constitute the vast plain of the South-East, extend across the Victorian frontier, and occupy the basin of the Lower Glenelg River, thence the coast line by Portland, Warrnambool, and Cape Otway to Geelong. This portion of South Australian geology has had not a few historians, the earliest of whom was Sturt, who, in tracing down the Murray from the Murrumbidgee in 1829, found that the river at about 130 deg. long. (somewhat eastward of the boundary of this province) entered a gorge, the limestone walls of which were highly charged with marine fossils. The description of the River Murray Cliffs given by Sturt (see Expeditions in South Australia, vol. II., p. 139, 1843) is to this day the only published source of information respecting the most interesting of the geological features of this colony. Nevertheless, the rocks and fossils of the River Murray have a long story to tell, for though Sturt's observations are accurate, yet he did not view with the eye of the experienced geologist.

Passing to that portion of the Murray Basin which centres around Mount Gambier, we have in the several works of the Rev. J. E. Woods, F.G.S.—particularly in his "Geological Observations in South Australia," 1861—an exhaustive treatise on the stratigraphical phenomena, not only of the Older Tertiary beds, but of the newer deposits, of this the most diversified portion of this province.

The Aldinga and Yorke's Peninsula Basin. I have already referred to the occurrence of Older Tertiary strata in two disconnected areas on the east side of St. Vincent's Gulf, viz., the Myponga Flat, and the Willunga Plain. Other patches of smaller size are the ridge which extends from Adelaide to the Stockade, and at Gawler, and at further points still further north towards the head of the Gulf. These are remnants of a vast sheet which must have occupied the greater part of what is now St. Vincent's Gulf, as similar beds form the north-west coast line of Kangaroo Island, and the whole of Southern Yorke's Peninsula, extending as a littoral fringe as far north as Ardrossan. On the shores of Spencer's Gulf these strata continue northward beyond Wallaroo, and probably continue around the head of the Gulf.

Mr. Tepper has occupied himself with the stratigraphical phenomena of these rocks about Ardrossan, and has endeavoured to bring them in accordance with those at Aldinga, briefly sketched by me in last year's "Transactions."

The Bunda Basin, details concerning which have been communicated to you in my paper "On the Natural History of the Bunda Plateau," published herewith.

It is probable that the marine beds do not in either the Murray or the Aldinga Basins rise to more than 200 feet above sea level, and that the general upper level does not exceed 150 feet; but their elevation is certainly as much as 250 feet in the seaward edge of the Bunda Plateau, and must be at least 100 feet more in its interior.

*Correlation and Age.*—The Rev. Mr. Woods has grouped what I have called the Older Tertiary rocks of the South-East Plain into three divisions, based upon physical, lithological, and palæontological differences. Independent observations on the rocks of the Murray Cliffs and of the Aldinga and Bunda Basins have led me to the adoption of a like classification; though I am not sure that the arrangement is identical in each case, and it is certain that we are not in accord as to the correlation of the various members in the eastern and western parts of the Murray Basin, and their relation to the Victorian beds.

In the following table I have arranged the divisions recognised by me, in reference to typical sections in each of three basins:—

<table>
<tr><th>R. Murray Cliffs.</th><th>South-East.</th><th colspan="2">Aldinga.</th><th>Yorke's Peninsula.</th><th>Bunda Cliffs.</th></tr>
<tr><td>Upper Murravian. Shell limestones oyster beds, and sands.</td><td></td><td colspan="2">Upper Aldinga series. Calciferous sandstone, impure limestones, oyster banks.</td><td>Crystalline limestones at Tickera. Turritella grits at Ardrossan.</td><td>Marbles.</td></tr>
<tr><td>Middle Murravian. Calciferous sandstone with polyzoa.</td><td>Yellow polyzoal limestone of Narracoorte.</td><td rowspan="2">Polyzoal sand-rock, marls, sands and earthy limestones.</td><td rowspan="3">Lower Aldinga Series.</td><td rowspan="2">Muloowortie clays.</td><td>Polyzoal limestone.</td></tr>
<tr><td>Lower Murravian. Ferruginous sandstone and polyzoal limestones.</td><td>White polyzoal limestone of Mount Gambier.</td><td rowspan="2">Chalk rock.</td></tr>
<tr><td></td><td>Chalk rock of MacDonnell Bay.</td><td>Glauconitic limestone.</td><td></td></tr>
</table>

The fossiliferous formations of the River Murray cliffs have, from their first discovery, been referred to the Tertiary epoch; and those of the South-East have been regarded by their describer as with them forming part of only one deposit. The Victorian geologists recognise different groups of strata in their Tertiaries; and have applied to them classificatory terms such as are used by European geologists to designate the primary divisions of the Tertiary epoch. Prof. Duncan strongly condemns this practise, and advises us to speak of the Australian Tertiaries, as older, middle, or newer; and he has set the example by calling the strata under review as Middle Tertiary. But the very same grounds which justifies the application of "Middle" will justify the employment of "Miocene" or other term, which simply expresses the age of the fauna relatively to that of our own shores. The principle of classification introduced by Sir C. Lyell is equally applicable to the Australian as to the European Tertiaries, as merely expressing the absolute proportion of locally recent to extinct species in a given deposit. And it seems to me that so far as the Australian deposits are concerned, no other meaning is intended to be conveyed by the terms made use of.

That the Australian fossil fauna shows an increasing specific relationship to the recent fauna, as we rise in the series of Tertiary deposits, cannot be denied. In other words, our continent has had its successive periods to which the terms Eocene, Miocene, and Pliocene may usefully be given, without implying that these were synchronous with those of the European.

To what period or periods of the Tertiary era should be assigned the South Australian deposits? I will not answer the question direct, or without reference to the classification employed by the geologists of Victoria. Of the several localities, yielding Older Tertiary fossils, none perhaps has had its organic remains so fully illustrated as Muddy Creek, near Hamilton; and apart from the published data for comparison, I have collected a very large suite of fossils from the beds at that place. If contemporaneity be proved by identity of organic contents, then the Muddy Creek beds are the direct equivalents of the Upper Murravian series, as is shown by the following summary of the results of a careful comparison between the fossils from each. Nearly all the Muddy Creek species described by McCoy and Woods are in my collection, but the few desiderated forms are included in my enumerations :—

| Classes represented. | No. species in Upper Murravian. | No. species in Muddy Creek Beds. | No. species common. |
|---|---|---|---|
| Cephalopoda | 3 | 1 | 1 |
| Gasteropoda | 89 | 210 | 64 |
| Conchifera | 34 | 43 | 24 |
| Palliobranchiata | 3 | 7 | 2 |
| Echinodermata | 2 | 3 | 2 |
| Corals | 7 | 24 | 6 |
| Total. | 138 | 288 | 99 |

The classes of Mammalia, Pisces, Crustacea, and Annelida show each a few species in common, but the total numbers in each in class are very small. Polyzoa are, however, represented by numerous species at both localities, but their examination has not yet been attempted, though a cursory glance impresses you with the belief of the complete identity of the two collections. The large percentage of seventy-two of Upper Murravian fossils present in the Muddy Creek beds justifies the assertion made last year (Phil. Soc., p. 121) that the upper marine strata exposed in the River Murray cliffs are the direct equivalents to the Muddy Creek beds. Having thus brought the youngest member of our Older Tertiary into co-relation with the Muddy Creek beds, the next step in the inquiry is to ascertain the age of the latter, the much larger number of fossils contained in which makes this indirect method the more satisfactory. The Victorian geologists do not seem agreed on this point. McCoy oscillates between Upper Oligocene and Older Pliocene, whilst Selwyn regarded the Muddy Creek beds as the oldest of the Tertiaries in Victoria, an opinion with which I do not concur. The proximity of the Older Tertiaries of Tasmania, which occur on the north coast at Table Cape, to the Older Tertiary deposits of Victoria, suggests the propriety of correlating them with those of the mainland; and so far as the examination of a limited number of their fossils goes, I consider them to be the equivalents of the Muddy Creek beds, and, therefore, probably of those at Geelong. Not having critically compared all the Muddy Creek fossils with living forms I am not prepared to express more than a tentative opinion on the proportion of living to extinct species; but of the 288 species, eighteen are certainly recent, or a little more than 6·2 per cent. I therefore think that we may safely refer the Muddy Creek beds to the Miocene period. Even by taking collectively the fossils in contemporaneous beds, the proportion of living to extinct species is not more than six per cent. The living species fossilised in these beds are as follows:—

The identification of those species marked by an asterisk (*) is on the authority of the Rev. J. E. T. Woods, and those marked thus ‡ on the authority of Prof. McCoy. † Indicates that the author has examined the species.

| | | Upper Murray. | Aldinga. | Muddy Creek. | Table Cape. | Recent. |
|---|---|---|---|---|---|---|
| 1. | Ancillaria Australis, Quoy | *† | .. | *† | * | N. Zealand. |
| 2. | *Syrnola bifasciata, Woods | .. | .. | * | .. | Tasmania. |
| 3. | Cochlolepas foliaceus, Quoy | .. | *† | *† | .. | S. Australia. |
| 4. | *Liotia discoidea, Rv.? | .. | .. | .. | * | Tasmania. |
| 5. | Fissurellidea concatenta, Crosse | *† | .. | *† | * | S. Australia. |
| 6. | Fissurella nigrita, Sow. | .. | .. | *† | .. | S. Australia. |
| 7. | Tugalia parmophoridea, Quoy | *† | .. | *† | .. | S. Australia. |
| 8. | Emarginula striatula | *† | .. | *† | .. | N. Zealand. |
| 9. | Emarginula dilecta, Angas? | *† | .. | .. | * | S. Australia. |
| 10. | Cylichna australis, Quoy | .. | .. | .. | *† | Tasmania. |
| 11. | Cadulus acuminatus, Deshayes | | .. | *† | *† | S. Australia. |
| 12. | *Dentalinm lacteum, Deshayes? | | .. | .. | * | India. |
| 13. | Ostrea (cf) edulis, Lin. | *† | *† | .. | .. | Temp. Seas. |
| 14. | Pecten bifrons, Lk. | .. | *† | .. | .. | S. Australia. |
| 15. | Pecten asperrimus, Lk. | .. | *† | .. | .. | S. Australia. |

| | | | | | | |
|---|---|---|---|---|---|---|
| 16. | *Leda inconspicua, Rv. | .. | .. | * | .. | —— |
| 17. | Limopsis Belcheri, Adams | *† | *† | *† | .. | S. Australia. |
| 18. | ‡Limopsis aurita, Sassi | .. | .. | *† | .. | Europe. |
| 19. | Pectunculus laticostatus, Quoy | *† | .. | *† | * | N. Zealand. |
| 20. | ‡Trigonia acuticostata, McCoy | *† | *† | *† | .. | E. Australia. |
| 21. | ‡Corbula sulcata | *† | .. | *† | *† | W. Africa. |
| 22. | Terebratella Cumingiana, Davidson | .. | .. | *† | * | N. S. Wales. |
| 23. | *Sphenotrochus variolaris, Woods | .. | .. | * | .. | N. S. Wales. |
| 24. | Flabellum candeamum, Ed. and H. | .. | .. | *† | .. | China. |

Other fossils have been referred to living species—to *Trivia Europæa*, *Leiostraca subulata*, *Lima subauriculata*, *Liotia lamellosa*, Woods, &c., but competent authorities have not confirmed these identifications. On the other hand, the Geelong coral, *Deltocyathus italicus*, Ed. & H., better known from the Italian Miocenes, is considered by Count Pourtales and Sir Wyville Thomson to be specifically distinct from its living analogue inhabiting the deep waters off the coast of Florida—an opposite opinion to that held by Professor Duncan. *Flabellum distinctum*, Ed. & H., a living coral in the Chinese seas, is fossil in the Victorian and South Australian Tertiaries older than the Muddy Creek beds.

If, then, we relegate the youngest member of our older Tertiaries to the Miocene period, where are we to place the older ones, particularly the inferior beds of the Aldinga series? The Lower Aldinga series contains not only a large number of restricted species, but a small modicum of recent forms. Thus of 116 known forms 34 pass up into the Upper Murravian and its contemporaneous deposits; whilst the number of recent species is not more than four. A summary of the determinations upon which the above figures are based is set forth in the following table:—

| Classes. | No. Species in L. Aldinga Series. | No. Species common to L. Aldinga Series and the Upper Murravian and Muddy Creek Beds. |
|---|---|---|
| Cephalopoda.............. | 3 | 2 |
| Gasteropoda............... | 40 | 15 |
| Conchifera ............... | 23 | 9 |
| Palliobranchiata .......... | 18 | 6 |
| Echinodermata .......... | 21 | 1 |
| Corals .................. | 11 | 1 |
| Total .............. | 116 | 34 |

The living species present in these beds are:—

TEREBRATELLA CUMINGIANA, Davidson. Very rare in the middle beds of the Aldinga section, but plentiful in the Lower Murravian, and in the Mount Gambier beds.

FLABELLUM DISTINCTUM, Ed. & H. Common.

LIMOPSIS AURITA, Sassi. The Aldinga fossils are identical with the New Zealand and Chilian Eocene form, *L. insoluta*, Sow., which may be synonymic with the above.

EMARGINULA DILECTA, Angas. An *Emarginula* from Aldinga is doubtfully referable to *E. transenna*, Woods, of the Table Cape Miocene, which may possibly prove to be the recent South Australian *E. dilecta*.

Accepting the above determinations, the proportion of living to extinct forms in the Lower Aldinga series is, expressed by percentage number, 3·5. And if the species of the Middle and Lower Murravian and of their equivalents in the South-East be similarly compared, I am confident that the percentage of living species will not be materially increased, though a larger percentage of forms will be found to pass from the middle to the upper series. But if we confine our examination to the fossils of the glauconitic limestones at Aldinga and of the contemporaneous chalk rock of the Bunda cliffs, we not only find a larger number of peculiar genera and others alien to the recent Australian fauna, but encounter some points of contact with the Eocene fauna of New Zealand. Regarding the last particular I can speak with confidence as to the identity of six of our fossils with those from the Upper Eocene or Ototara group of New Zealand, but in the absence of actual specimens for comparison I hesitate to refer several others to species from the same deposit.

The obviously higher antiquity of the fauna of the glauconitic limestones at Aldinga necessitates the separation of our Older Tertiaries into two distinct groups—the one referable to the Eocene, the other to the Miocene; and it may be well, for the present, to regard the Upper Murravian series as Upper Miocene, and the middle and lower portions as Lower Miocene, restricting the Eocene as indicated above.

### UPLAND MIOCENE AND DESERT SANDSTONE.

There succeed in conformable position to the uppermost marine beds at Aldinga, at Adelaide, and along the banks of the Lower Murray River, unfossiliferous clays, which from the fact of their gradual passage into beds presenting unmistakable evidence of fluviatile origin, may be regarded as estuarine.

The shore line of the Miocene sea is distinctly traceable at a few points in the Aldinga Basin. Passing inland from the mouth of the Onkaparinga, the marine beds, which form the bold headland of Wilson's Bluff, gradually change their character, and at Noarlunga give place to sands and shingle.

Again, the scarped ridge east of the main street of Gawler is made up of coarse sands crowned by rounded gravel; the sands contain blocks of stone, resulting from consolidation of the sands by carbonate of lime, which yield a few marine fossils, and also silicified stems, having a structure resembling that of *Casuarinæ* and *Eucalyptus*. The process of silicification took place subsequent to entombment in the marine or estuarine beds, because the stems are not unfrequently found to be drilled by Teredos. As we proceed towards the ranges, the depressions in the Palæozoic rocks are levelled up by more or less angular gravel, either loose or consolidated into a compact conglomerate; whilst at higher levels on the foot hills of the Adelaide chain evenly-bedded sandrock, mottled clayey sands, and ironstone conglomerates occupy flat-topped heights, conspicuous by their scrub vegetation. If we trace the mottled clays, which cover the fossiliferous limestone at Adelaide, towards the north, we find that they are coterminous with beds identical with those just described. Indeed, strata of this character occur in patches of great or less extent from the Hope Valley Reservoir, Teatree Gully, to Golden Grove, thence to Gawler Town Hill, where they attain an elevation of 950 feet. They constitute the gold drifts of the Barossa and Humbug Scrubs, and stretch away in a narrow band by Lyndoch, Tanunda, and Nuriootpa. No other fossil remains than silicified tree-stems similar to those at Gawler have been met with in these Upland Miocenes. The amount of denudation that they have been subject to is immeasurable. They now occur as disconnected patches, separated from one another by deep ravines, and are only remnants of a long narrow incline plane bounded on the east by the Adelaide chain, but whose western confines are not extant, as in many places they form the highest ground on the Gawler Hills.

The littoral beds at Noarlunga conduct us to beds of a like nature, and doubtlessly similar origin, forming the gold-field of Echunga. In the same category must be placed the Tertiary beds of Myponga Flat, the sandstones and ironstones at Yankalilla, which there overlie marine Miocenes, the varied sandy beds constituting the scrub-lands to near Cape Jervis, among the hills to the north of Victor Harbour, along the eastern slopes of the Adelaide chain, extending northward along the valley of the Bremer to Callington.

The character of the gravels and their relation to the marine Miocenes must, in the absence of positive evidence to the contrary, be regarded as indicating a fresh-water origin. I may remark in connection with the clays overlying the Miocene limestone that it is on their surfaces that the "Bay of Biscay" land prevails. This name is applied to tracts covered with mounds or ridges grouped in the most irregular way, and without any relation to the natural slope of the surface. The ridges, which rarely exceed a foot in height, are composed of clay, whilst the depressions are occupied by alluvium or sandy loam; and though it is generally held that the soil of the depressions extend in depth, yet my observations are totally opposed to that view. How the depressions have been formed on the clay soil, and how they have been subsequently partially filled, are questions which I hope will occupy the attention of some member of this Society.

On the Murray plain these clays are surmounted by sands, which occupy ridges surrounding plains constituted of the former; and though proof is wanting of their cotemporaneity with the Upland Miocene, yet it is not unlikely that they belong to the same epoch.

Immediately to the west of Lake Torrens the country is occupied by hard sandstones, clays, thin beds of ironstone, and gypsum; and, according to my informant, very extensive sections of these strata are exposed in the Bosworth Creek and at Andemokka. At Bottle Hill, at one mile south from Edge Hill, and between the Elizabeth Station and Coondambo, the hard sandstones there have yielded to the researches of Mr. William L. R. Gipps a plentiful supply of fossil leaves, for the most part Eucalyptoid. No other fossils were observed in these sections.

From the published description of scientific travellers, and from other sources of information, we gather that the rock formation of much of Central Australia partakes of the general character of the beds about the western shore of Lake Torrens. It is, however, hidden over considerable tracts by gravelly drift, in part derived from the subjacent sandstones. And I think that there can be little doubt that it forms a part of the "Desert Sandstone," so called by Mr. Daintree, because of the sandy, barren character of its disintegrated soil. The same author describes the formation in Queensland as unconformably overlying Cretaceous rocks and underlying lava beds, and states that all the available evidence tends to show that this "Desert Sandstone" did at one time cover nearly, if not quite, the whole of Australia. The position of the formation is presumptive evidence of its Older Tertiary age, as so far as is known the volcanic outbursts seem to belong to the Newer Tertiary period. Mr. Daintree has found in it fossil wood, but no marine fossils; though he had recorded the occurrence of a *Tellina*, but the locality he gives to it is a mistake. (See Clarke, "Sedimentary Formations," p. 95).

There is much reason for the belief that the "Desert Sandstone" is an extensive lacustrine deposit; coeval with the accumulation of the river gravels and sand of the hilly country classed by me as Upland Miocene.

*Summary.*—The marine Older Tertiaries, which belong to the Eocene and Miocene epochs, are confined to the existing coast-line, and extend inwards from thence in gulf and bay-like projections. They do not attain an elevation much above 250 feet. Beyond these are the vast sterile tracts of the interior of the continent occupied by the lacustrine formation termed the "Desert Sandstone," which is contemporaneous with the youngest member of the Miocene marine strata. At various places in South Australia, Victoria, and New South Wales plant-deposits occur among silicified sandstones and quartzites, often at great elevations and in several instances associated with the goldfields underlying the basalts.

Some excuse may be tendered on behalf of those, who, having no other source of information than that contained in Brough Smyth's geological map of Australia, have indulged in representing this continent during Miocene times as being for the most part submerged beneath the ocean. These Tertiary deposits were not subjected to any other alterations in their relative level than those of the most local kind. The elevation of the southern shores of the continent at the close of the Miocene period was equable, and measured by the vertical thickness of the deposits and heights at which its littoral margins now exist, it could not be more than about 150 to 200 feet within the Aldinga and Murray Basin. A depression to this amount would not submerge the interior of the continent, and would be too small to materially affect the rainfall, so that the vast rivers which now drain the Cordilleras must have then, as now, flowed in the same direction, but have discharged their waters into the great central basin—bounded on the north by the Highlands of New Guinea, on the east by the Great Dividing Range, extending on the south to the Grampians of Western Victoria. This vast inland lake or estuary was dotted with islands now forming the elevated parts of the Flinders and Adelaide Ranges, and other mountain masses in Central Australia, each with its own river basins in which were accumulated the fluviatile gravels which are scattered at various heights among our hills.

The denudation of the Desert sandstone since it became dry land has been excessive, and that of the marine deposits has been very great, as is fully attested by the existence of the wide gulf of St. Vincent's which is excavated out of them, and by the precipitous front of the Bunda cliffs and their ascertained extension below sea level for a distance of several miles.

The absence of marine Older Tertiary from the eastern flanks of the Cordilleras may probably be due to removal.

The general surface of the marine beds has, however, not been much affected by denudation, but the River Murray has cut deeply into them, leaving high yellow cliffs about one and a quarter miles apart.

### Pliocene Drift or Loess.

This remarkable formation forms the soil of the fertile plains on the western slopes of the Adelaide chain, and among the Northern ranges, and occupies a long strip of country of a few miles in width bordering the western margin of the Murray Basin.

It everywhere presents the same general character and qualities, and is doubtlessly the residuary disintegrated material of the slates, limestone, gneissic, and granitic rocks of the adjacent ranges. From the circumstance of its occurrence at different altitudes in various parts of the country, as also from the nature of its derivative ingredients, there can be little doubt the material of each plain or flat is of local origin. Among the derivative materials of the loess in the Valley of the Torrens at Adelaide, I have found Miocene limestones enclosing characteristic fossils, derived from the contiguous cliff ; thus proving the Post-Miocene age of the formation. Nevertheless, the margin of each basin is at a uniform level.

The loess is a calcareous loam, divided into beds by irregular bands of clay or sand, which thin out at the borders, where they are replaced by angular pebbles and large blocks of stone, derived from the adjacent hills. The loess is very friable, yet consistency is imparted to it by the presence of tubular pores, branching downward like rootlets, which are lined with carbonate of lime.

The uniformity of the surface of each plain is only interrupted by the vertical walls between which all the members of a most labyrinthine valley system are sunk. Though the drift is wholly unstratified, its vertical internal structure causes it to break off in any vertical plane, but in no other ; hence when a cliff is undermined the loess breaks off in immense vertical plates, leaving again a perpendicular wall. The rapidity with which even the smallest streams cut out deep channels in it is a fact that is patent to all. Channels now several yards in depth and width have been eroded in a few years along the line of a plough-furrow or of a dray-track.

Another peculiarity of the loess is that it contains the remains of only land animals and terrestrial vegetation. The land animals are restricted to some of the extinct mammalia, *Diprotodon* being particularly abundant in the loess of some of the plains of the Northern Areas. Land mollusca have been found in the loess of the Bunda Plateau.

The absence of marine organisms, and the fact of the deposit occupying tracts varying from three to ten or more hundred feet above the sea level prove in the most conclusive manner that a marine origin is impossible. I would suggest that the sea-worn pebbles found by Mr. Scoular in the loess of Munno Para have been derived from the waste of the shingle beaches of the Miocene epoch, remnants of which are still *in situ* at a few places among the Gawler hills.

The accumulation of the loess cannot arise from the silt brought by the rivers flowing from the hills into the plain without the aid of some distributing agent, inasmuch as the rivers denude the loess, and only in extreme cases when they overflow their banks do they distribute material over the plains, though it must be conceded that our streams may havs lost their tendency to accumulate, and have in consequence acted as denuding agents. But, nevertheless, the accumulations from our short streams would have been concentrated about the points where they debouched upon the plain.

Indeed, I cannot resist the conclusion to which I have been led, chiefly from topographical reasons, that the loess has been deposited in a series of lakes; a subaqueous origin fulfils the required conditions, though the subaerial theory of loess formation propounded by Richthofen would equally account for the assortment of the material. Wind plays an important part in this colony as a geological agent, writes Mr. Scoular; and most of us have realised the capacity of wind as a transporter of fine material. And it is highly probable that this agent was largely concerned in the accumulation of the loess of the southern margin of the Bunda Plateau (see page 116).

One fact pointed out to me by Mr. Smeaton, confirmatory of my opinion that the drift of the Adelaide Plain was assorted in a lake, is that of the northerly trend of all the streams on their emergence from the hills, in which their general direction is to the west. My explanation of the phenomenon is as follows:—In consequence of the prevalence of south-westerly winds then as now, the direction of the current of the stream would be deflected towards the north as its volocity was slackened on coming in contact with the lake water, but before commingling with it. Thus would be formed a subaqueous channel which would be projected lakewards as the waters slowly decreased, and along which the lengthening streams would naturally flow.

My theory of the formation of the drift requires climatical conditions somewhat different from those which now obtain; it demands the operation of aqueous agents more active than now. It implies a period of greater precipitation. If the loess be the insoluble products of the weathering of rocks, has the material been removed by the action of the rain, or as the ground moraine of glaciers? Was there ever a time when large masses of ice descended down the gullies and discharged the ice-borne materials into a lake? We know that such an agency is at work in New Zealand, and in past times its glaciers descended far lower than their present termini.

I cannot connect the accumulation of the loess with the glacial phenomena about to be described, and though the glacial theory of its origin may account for the facts, yet it does not follow that the theory is true.

One familiar with the appearance of a glaciated country cannot have failed to recognise a certain resemblance that our hills bear thereto. Mr. Woods writes:—"Indeed, it seemed to me that there were very distinct marks of snow, and the action of glaciers. This would declare the range to have been once of extraordinary elevation, probably the axis of some former continent" (Geol. Obs., p. 20). I shall be asked at once whether glacial inscriptions have been found—the grooves, striæ, and polished surfaces so characteristic of the rocky surfaces over which glaciers have travelled. I answer that such traces of moving ice do occur. They are—(1) Smooth, striated, and grooved rock surface in the bed of the Inman, Cape Jervis Peninsula, as recorded by Mr. Selwyn in the following terms: —"The direction of the grooves and scratches is east and west in parallel lines, and though they follow the course of the stream I do not think that they could have been produced by the action of water, forcing pebbles and boulders detached from the drift along the bed of the stream. This is the first and only instance of the kind I have met with in Australia, and it at once attracted my attention; strongly reminding me of the similar markings I had so frequently observed in the mountain valleys of North Wales."

I may quote *en passant* the words of Mr. Howitt (Quart. Journ. Geol. Soc., vol. xxxv., p. 35, 1879) referring to glacial signs in the mountain-tracts of Gippsland, Victoria:—"I have nowhere met with grooved or scratched rocks, &c., or any traces of ice-action; and I think that had such existed they would have been met with ere this. Mr. Selwyn has, I believe, already noted this. The only features of the country which I think could in any way suggest glacial conditions are the apparently ancient lake-basins near Omeo."

In all the discussions which I have read on the question—Did Australia participate in a glacial period analogous to that of the Northern Hemisphere?—I find no reference made to Mr. Selwyn's observation, quoted above; probably because unknown, possibly because of its uniqueness. Recent discoveries confirm, however, the correctness of that gentleman's interpretation of the signs.

(2.) Smooth, grooved, and striated rock surface, and moraine *debris* at Black Point forming the southern boundary of Holdfast Bay.

That headland presents a steep cliff face of about 50 feet high to the sea, and there stands back a few yards from its edge a low mural escarpment of Miocene. The intervening space, which is nearly flat, is covered by drift material, chief amongst which are angular stones and blocks of red granite, gneiss, hornblendic slate, and quartzite; the nearest depot for which is at Normanville, 35 miles to the south. Over some few square yards, the drift has been removed, disclosing a smooth surface of siliceous slate, striated and grooved in a north and south direction.

(3.) Passing to the south, across the mouth of Field's River, moraine *debris* and larger masses of transported rocks are seen encumbering the flat tops of the sea-cliffs.

(4.) Other signs, which taken alone would have little value, but read in the light afforded by the indubitable signs of glaciers in the valley of the Inman and at Black Point, come to have significance; these are the *roches moutonnées* surfaces of the mica slate on the south flank of Kaiserstuhl, and similarly large rounded surfaces at Crafer's, both localities in the Adelaide chain.

The late Sir R. Hanson had in his possession, so I have been informed, an ice-worn pebble, obtained from the Torrens drift. Mr. J. D. Woods, in letter May 14, 1877, supplies the following particulars:—"I think that if you investigate the Torrens Gorge, you will find evidences quite as strong as those quoted by Mr. Selwyn. On one side of a hill there is a stream of *debris* which my brother (Rev. J. E. T. Woods) considered to have been left by a moraine. In the bed of the river, near the cottage on the right side, there is a lump of rock, which some twenty years ago used to be called the "elephant rock" from its outline. The front part of it has been broken away, so now it retains nothing of the special characteristics which gave it its name. The sides are indented with striæ and there seems to be no doubt that it must have been carried by some force from a long distance."

Such are the signs of the former existence of ice-action in South Australia. If the ice originated within the country, then it must have been the result of either

1. The prevalence of a very much colder climate, or
2. That the land stood at much greater altitude (say 10,000 feet), or the mountains may have had a more plateau-like form, and therefore need not have been so high, and consequently collected more snow, or
3. A combination of both.

If, however, the scratches and moraine *debris* be attributed to the grounding of icebergs shed from the highlands of the Southern Ocean, as conjectured by Mr. Scoular, then a considerable amount of depression must have taken place, and to account in this way for the deposition of the drift and for the presence of the obsidian bombs scattered here and there throughout the whole of the southern parts of this province, the depression must have been great enough to submerge all of the province below 1,000 feet or so in elevation. I need hardly add that the known facts do not warrant such assumption.

On the limestone surfaces of the Murray Basin and the Bunda Plateau the loess is absent over very large areas, and when present is of very shallow depths. In these areas it could only originate from the insoluble residue of its limestone rocks, which from their purity could only yield an appreciable quantity by secular decay continued through prolonged periods. In the oasis of the Bunda Plateau the subaerial origin of the loess is incontestably shown, and it is highly charged with land shells, vegetable *debris*, from top to bottom.

The loess in the South-east Plain is mainly preserved in the pockets and depressions of the Miocene limestone, and in the neighbourhood of the volcanic cones is covered up by ash beds. It contains the remains of the large extinct Mammalia, and the period of its formation must be coeval with that forming the fertile plains of Adelaide, &c. At this time the caves in the South-east must have been frequented by the extinct mammals whose remains are embedded in their stalagmitic floors.

*Retrospective Glance.*—During the Pliocene period the land was much elevated, probably into regions of perpetual snow. The continent was then obviously vastly more extensive than now. Tasmania and New Guinea would then be united to the continent, as is required by the community of species of certain plants and animals. It was during this time that the large mammals roamed over the land, and the wide expanse of country allowed of the development of its peculiar and extensive fauna. The climate moister, and the temperature of lowlands more equable than now, and generally the conditions were favourable to the growth of succulent herbage capable of sustaining a large and varied mammalian fauna. The seas that laved the shores had their inhabitants, but of them we have no record, because the sites of their habitats are now far beneath the waters. This period was brought to a close by the lowering of the land—gradually, it may have been—and in consequence of which its glaciers retreated and finally disappeared, and the fertile tracts of the lowlands were submerged, and the productive powers of other areas diminished by the gradual dessication going on. In this way the animals would be crowded on limited areas, and a struggle for existence would ensue, in which the less adapted and less easily modifiable would succumb. Of these the larger animals would probably be the first victims, because of their slow breeding powers and of insufficiency of food within easy reach. The clumsy Diprotodon would soon be worsted in the struggle, while the fleeter Kangaroos could continue to hold their own for a longer period; and the extinction of the Thylacoleos would be involved in that of its prey.

Comparing the climatic conditions of the Pleocine Period—distant, but geologically recent, with those of the Present Period—we cannot doubt that a great change has come over the surface of South Australia in the decreased amount of water in the lakes or running in the rivers, in the increase of its mean annual temperature, and in the depauperization of its mammalian and avian fauna. Historical evidence affords no data, and exact observations with the raingauge cannot possibly have extended over a sufficient length of time to enable us to decide whether this change has been continued to our time. What little evidence can be adduced from geological observations is to the effect that the tide of dessication has turned, rather than to its continuance. The evidence to which I allude is that of the recent elevation of land, by which process our hill-tops are lifted into higher and colder strata of the atmosphere, and aqueous precipitation is increased. That these changes have occupied a vast interval of time is proved by the amount of denudation our "Drift" has undergone, as exemplified by the truncation of the Adelaide and Willunga Plains. In the case of the latter the Drift forms seacliffs rising to an elevation of 350 feet, whilst its western boundary has been totally removed.

## Pleistocene.

The Rev. J. E. Woods describes the coast at Guichen Bay as consisting of rough craggy rocks of coarse-grained sandstone, "which, though not rising very high, are bold and abrupt, sometimes presenting a perpendicular face to the heavy surf which beats upon that coast." He recognises the false bedding, notes the absence of fossils, and concludes "that the deposit was from ocean current, but also that it was a considerable distance from any land." He further remarks that it is found more or less all round the coast of the colony of South Australia, and perhaps it extends all along parts of the Australian Bight. Personal examination of much of the whole coastline between Cape Northumberland and Eucla confirms the statement of Mr. Woods. In my paper on the country around the Head of the Bight I have described this formation somewhat in detail; and the phenomena observed there are common to all sections on whatever part of the coast, namely, coarse sands and sandstones, distinctly false-bedded, and though consisting of minute shelly particles and particles of quartzose and calcareous sand do not contain marine shells, but are often highly charged with the local land shells. These appearances clearly indicate that the deposit was formed from blown sand. From the circumstance that it forms precipitous cliffs and is continued far out to sea, forming those submerged reefs which render the coast from Cape Northumberland to Guichen Bay so very perilous to navigators, I conclude that it is separably from the loose sand dunes, which elsewhere fringe the coast, and not unfrequently overlie it, by an interval of time marked by slight oscillations of level. In other words, that during the period of its accumulation the land stood relatively higher than it does now. This was succeeded by a depression amounting perhaps to not less than 20 feet to allow of the sea to overflow those extensive low-lying areas occupied by deposits containing existing marine species, which occur all along our shore margin.

*Upheaval of the Land* during the epoch of recent species is attested by the occurrence of raised beaches, such as at Edithburg and Victor Harbour, and by the elevated sea beds which in the South-East extend inland for several miles, and which at several points along the whole coast occupy considerable areas of what are now sàlt-swamps, such as those of Port Adelaide and Dry Creek, at Port Wakefield, at Fowler's Bay, &c.

The alterations of soundings on rocky ground at Rivoli Bay and at Cape Jaffa evidence that the elevatory movement is still progressing.

As to the height to which the land has been raised in recent times, many erroneous observations have been made. Mr. W. H. Light in a paper on the elevation of the Australian coast read before this Society in 1855 appeals to the fossiliferous deposit under the City of Adelaide in evidence of recent elevation. "The present vertical elevation of the highest fossiliferous stratum near North-terrace above the level of the sea, at ordinary high water is about 94 feet. Add to this the supposed limit of depth below the surface at which the beds of shells have been formed—say 50 feet—and we get a height of 144 feet as somewhere about the probable extent of elevation which this stratum has received." The Rev. J. E. Woods committed the same mistake in referring (Geol. Obs. p. 208) the Adelaide fossiliferous limestone to the Recent Period, whereas it belongs to the Miocene. And, though correct in identifying the *travertine* on Tapley's Hill at about 1,000 feet above sea level, with the limestone crust overlying the Miocene limestone at Adelaide, yet he made a great mistake in attributing to it a marine origin, and in consequence his deduction that our hills had been raised that amount within a very recent period is based on wrong premises. Mr. Selwyn has equally misunderstood the nature of the "crust limestone." Mr. Woods, writing about the extensive area occupied by recently-raised marine beds in the South-East, has not been able to give actual heights above sea level, but ventures to estimate the amount of upheaval at not less than 80 feet. However, it is not clear, that these figures refer to the height of the shell beds or to that of the terraces of Pleistocene sandstone, similar to those of Cape Northumberland and Rivoli Bay, which divide the plain from the Coorong to Lacepede Bay at every ten miles or so.

Accurate measures of the height of the marine beds composing the salt marshes resting on the Port Creek, and at Yalata, Fowler's Bay, determine that the elevation is of only slight amount.

The estuarine limestone, which fringes the Dry Creek salt marsh, and which is of about six to twelve inches thick, and crowded with *Amphibola Quoyana*, *Risella melanostoma*, and other littoral shells, is not more than twelve feet above ordinary high water mark. The limestone overlies the drift, but graduates into the estuarine muds and sands which occupy the salt marsh. The marsh is at rare intervals overflown, but extraordinary tides do not reach the estuarine limestone.

The topmost bed of the marine deposits of the Yalata swamp is only six feet above high water mark, whilst that of the Roe Plains at Eucla is about twelve feet.

Volcanoes of the South-East.—These have been very fully described by Mr. Woods, and but one question arises in connection therewith, viz., at what period were they erupted? They are newer than the Miocene, because the Mount Gambier limestone forms the base of the cones, and its fragments occur entangled in the ash beds; they are newer than the Pliocene sand and loess which are interstratified between the Mount Gambier limestone and the ash beds of the volcano of that place. The Pliocene sands and loess at this place are of terrestrial origin; they contain remains of *Diprotodon*, *Phascolomys pliocenicus*, McCoy; and leaves of *Casuarina* and *Banksia* are impressed on the under surface of the superimposed ash-layer.

Did man witness the showers of ashes and the glow of the internal fires of these cones reflected from the clouds? Probably yes! Have we any traditions? No? But palæontological evidence answers in the affirmative. Thus, the dingo (*Canis dingo*) was the contemporary of the *Diptrodon*, whose remains are buried beneath the ashes of the Mount Gambier volcano, as proved by their remains occurring together in the Gisborne and Wellington caves.

Now, the dingo is an alien; he forms no part of the Australian fauna; and his introduction by man, as a companion and assistant in the chase, can only satisfactorily explain his presence in this continent, as in some of the Pacific islands. Man and dog may have pursued together the *Diprotodon*, and in latter times have been awed by the volcanic outbursts. Indeed, no other cause of extirpation of the huge mammals has suggested itself to the mind of Professor Owen save that of human agency. He says, "To a race of men depending, like the blackfellows, for subsistence on the chase, the largest and most conspicuous kinds of wild beasts first fall a prey."

The volcanoes of the South-East, and particularly those at Mount Gambier, are characterised by the emission of much ash and litttle lava. The volcanic energy was weak, and it was the western limit of a force having its chief foci in Western Victoria.

Though tranquil as the eruptions had been, yet there is no guarantee that the volcanoes will not again become active, and that the volume of their vomitings will be as insignificant.

*Volcanic Ejectamenta beyond Present Craters.*—Osidian bombs, showing no marks of erosive action, have been collected at distant parts of the colony, occurring either loose on the surface or imbedded in the "crust limestone," I have seen a specimen obtained at Gawler, from the centre of a nodule of travertine; and several that were collected about Stuart's Creek, and one from King George's Sound. I incline to the opinion that their distribution has been effected by human agency—perhaps the wish is father to the thought—inasmuch as the only feasible explanation of their presence arising from natural causes militates against my theory of the origin of the loess. Briefly, the state of the case is as follows:—

1. The bombs have not been ejected from the volcanoes of the South-east, because they are not found within their neighbourhood.
2. They may have been the outcome of some volcanoes, all traces of which have been removed by the encroachment of the sea.
3. Or they may have been brought by icebergs from the antarctic volcanoes—Erebus and Terror. By these means Mr. Scoular explains at once the ice marks on the sea cliffs of St. Vincent's Gulf and the distribution of the volcanic bombs, an opinion I do not share with him, as previously explained.

These bombs are held in high estimation by the aborigines, a fact which proves inferentially that they are not common—that they are obtained perhaps with difficulty, and possibly by exchange. Other articles of *virtu* have been transported to different parts of the continent, and why not these? Though we may in this way account for their wide-spread distribution, yet the evidence is not conclusive till they shall have been traced to their natural sites.

I submit the following documentary evidence of the value set upon the obsidian bombs by the Australian black. A correspondent, writing from Salt River, King George's Sound, states:—"The black stones are very rare, and much prized by the natives, who believes the possessor bears almost a charmed life, and is able also to cure sick people of any complaint they may be afflicted with, as also to bewitch their enemies, or any one with whom they have a grievance, tormenting them with all kinds of diseases and finally destroying life itself." Mr. Canham, of Stuart's Creek, writes:—"With the stones will be found one to which a strange story is attached. I was told by the native I had it from that it was taken out of the breast of a sick man by one of their 'koonkies,' or doctors, who, however, did not succeed in saving the patient's life, as some other 'koonkie' of another tribe had a greater power than this one who took the stone out. The sick native, I mention, died here of disease of the lungs, and all the koonkies in the country could never have saved him."

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In conclusion, I lay before you a summary of such works and papers as have come under my notice bearing upon the natural history of this province which have been published during the past year; and also some addenda to the list furnished last year.

"Transactions of the Entomological Society of New South Wales," vol. 1, 1866; vol. 2, 1873.

The Society was founded in 1862, and is now merged into the Linnean Society. The two volumes published during its existence contain, as may be expected, most useful information for the Australian entomologist. Contributors thereto, aware that the descriptions of Australian insects are dispersed through so many different books, and transactions of scientific Societies, have, in treating upon native insects, reprinted the specific descriptions of known species as given by the various authors, and have thereby relieved in some measure colonial entomologists from the disadvantages they labour under from want of access to the literature of the subject.

The example set us by the Sydney naturalists might advantageously be imitated by workers in various departments, as well as by entomologists. Conspectuses of genera, accompanied by pictorial representations of types, when necessary, would greatly facilitate the labours of the student.

Mr. W. Macleay, in Presidential Address, vol. 1, p. 21., gives a brief summary of the earlier history of Australian entomology, down to the publication, in 1848, of Germar's paper in the "Linnæa Entomologica" on the insect fauna of South Australia, which affords fuller information than I gave in last year's address.

*Lepidoptera of the Family Zygaenidæ*: By A. G. Butler, Journal Linnean Society, 1875, 3 pl.

Four new species of *Hydrusa* from Australia are described, and references are made to some other Australian species. The paper is a correction and emendation of Mr. Walker's list.

*Description of Australian Micro-Lepidoptera*: By E. Meyrick, Proc. Linnean Soc., N.S.W., vol. 3, p. 175, and vol. 4, p. 205 (1878-9). The author estimates the total number of species occurring on the Australian Continent to be fully 10,000. A certain number of descriptions of Australian micro-lepidopters are stated to be included by Walker, in his Brit. Mus. Cat., and a few by Zeller, Norman, &c. The present communication deals only with the group Crambites, of which 71 are described, 50 being new, and one genus is established. The following species were collected about Adelaide:—*Crambus trivittatus*, Z.; *C. relatalis*, Wkr.; *C. bifractellus*, Wkr.; *Etiella Behrii*, Z.; *E. chrysoporella*, Mey.; *Homœosoma vagella*, Z.; and *Aphomia latro*, Z.

*Contributions towards a Knowledge of the Curculionidæ*: By F. P. Pascoe, part iv., 4 plates (Journal of Linnean Society, vol. xii., 1873. Forty-one species from Australia are described, four of which are from South Australia.

*Description of New Species and Genera of Eumolpidæ*: By J. S. Bailey. (Journal of Linnean Soc., vol. xiv., p. 246, 1878.) Three of the new forms are from this continent; and "*Descriptions of New Genera and Species of Gallerucinæ.*" (Ann. Mag. Nat. Hist., August, 1879, p. 108.)

A new species of pulmoniferous snail, living in the mangrove swamps about Port Adelaide, is technically described by Mr. Brazier, under the name of *Alexia meridionalis*, in Proc. Linnean Soc., N.S.W., vol. ii., p. 26 (1877).

Mr. E. Smith, marine shells from the Solomon Islands, Journ. Linnean Soc., 1876. Figures and describes *Nassa bicallosa* from Swan River; and *Thracia Angasiana* and *T. Jacksoniana* from Port Jackson, and reports the occurrence of *Terebra cancellata*, Quoy (*T. undatella*, Desh.) at Port Elliot.

Mr. Angas, in Proc. Zoological Soc., November, 1878, gives a list of additional species of marine mollusca to be included in the fauna of this Province. It is a supplement to a former list published in 1865, and includes a few published records of species that have not come under his observation, whilst the bulk of the additions is based upon material communicated to him by Mr. Bednall and myself. The list contains the names of fifty-four gasteropods, twenty conchifers, and one palliobranch.

Mr. Petterd describes, in Journal of Conchology, April, 1879, seven new species of Tasmanian marine gasteropods, chiefly from Bass Straits.

Prof. Hutton, on the structure of Amphibola avellana (Annals and Mag. Natural History, March, 1879). Though the species, whose structure is, herein, so ably described, is not a member of our fauna, yet as it is allied to two very common forms of our maritime marshes and mud shores, the knowledge of the animal must supply very important data for comparison to those who occupy themselves with the physiology of our molluscs. The anatomy of *A. avellana* was first studied by Quoy and Gaimard, and published in the Zoology of the Astrolabe, vol. ii., p. 196, t.15, f.1-8. Those observers ascertained it to be a pulmoniferous snail, with the pulmonary cavity closed in front, and that the sexes are united in each individual. Professor Hutton's researches have enabled him to correct inaccuracies in several points communicated by the French naturalists; though corroborating their observations in the foregoing particulars. The systematic position of the genus has not been agreed upon by macalologists, and though Prof. Hutton does not compare the anatomy of this snail with that of other pulmonates, yet his very ample dissections will enable the systematist to bring the genus into closer relationship with those to which it is most nearly allied in structure.

Woodward (Recent and Fossil Moll., 1854) includes it in the Family Paludinidæ—a group of freshwater branchiferous snails, to which *Amphibola* is related by the form of its shell and operculum. Gray placed it amongst the true pulmonifera; Binney (1865) classes it under Pulmonata, suborder Thalassophila, which is characterised by "eyes sessile on the front part of the frontal disk, formed by the expanded tentacles." Only two families, *Amphibolidæ* and *Siphonariadæ*, are included. The dentition of *Amphibola* indicates, as represented by Professor Hutton, a nearer alliance to the inoperculate pulmonifera than to the branchiferous snails.

The carcinologist will find in the following recent papers much information respecting the crustacea inhabiting the Australian seas. With one exception, that of *Micippe parvirostris* (Miers) obtained at Port Lincoln, all the species referred to are not known to haunt our shores, though several occur in contiguous waters:—

"Revision of the *Hippidea*." By E. J. Miers (Journ. Linnean Soc., xiv., p. 312, 1879).

"New or Little-known *Maioid* Crustacea." By the same (Ann. Mag. Nat. Hist., July, 1879; also Journ. Linn. Soc., xiv., p. 634, 1879).

"On two new species of *Stenorhynchus*." By W. A. Haswell (Proc. Linn. Soc., N. S. Wales, iii., p. 408, 1879).

"On the Australian Species of *Penæus*." By the same (loc. cit., iv., p. 38, 1879).

"Contributions to a Monograph of Australian *Leucosiidæ*." By the same (op. cit. p. 44).

"A New Australian Sphæromid (*Cyclura venosa*)." By T. R. R. Stebbing (Jour. Linn. Soc., xii., p. 146, 1876). It has close agreement with our *Cymodocea armata*, but differs in some particulars, which are by the author considered to be of generic value.

The Australasian species of the Amphinomaceous Annelides have been increased by Mr. Haswell from eight to fourteen in number (see Proc. Linn. Soc., N.S.W., vol. iii., p. 341, 1879).

"New and Rare Hydroid Zoophytes (*Sertulariidæ* and *Thuiariidæ*) from Australia and New Zealand." By D'Arcy W. Thompson (Ann. and Mag. Nat. Hist., Feb., 1879; plates 16-19).

Nineteen species of four genera of these families are figured and described. Most of the species were obtained principally in New Zealand, but also from St. Vincent's Gulf, Bass Straits, Torres Straits. The author remarks that the Hydroids of Torres Straits and the Louisade Archipelago are singularly different from those of the southern and south-eastern region—*e.g.*, Adelaide and Bass Straits; and the forms inhabiting New Zealand are singularly distinct from the Australian species.

"Diagnoses of New Genera and Species of Hydroida." By Prof. Allman (Journ. Linn. Soc., vol. xii., p. 251; plates 9-23; 1875).

In this paper a large number of new Hydroid Zoophytes from many widely-scattered localities are described. Among these are five new *Sertulariidæ* and three new species of *Thuiariidæ* from New Zealand.

Mr. H. Carter, Contributions to our Knowledge of the Spongida (Ann. and Mag. Nat. History, April and May, 1879), describes and figures from South Australian waters, *Trachycladus lævispirulifer*, n. gen. et sp., *Amorphina stellifera*, n. gen. et sp., and *Stellettinopsis corticata*, n. gen. et sp.; and the following from other parts of the continent:—*Suberites fuliginosus*, n. sp.; *Stellettinopsis simplex*, n. sp.; and *Samus anonyma*, Gray, *Axos*, two sp.

In Phanerogamic Botany, additional species to the South Australian fauna, than are contained in the Flora Australiensis, will be found in Baron von Mueller's Fragmenta Phytographiæ Australæ, the 90th fasiculus of which was issued in January, 1879.

The literature specially dealing with the fungi of Australia includes the following works omitted by me in my last address :—

FRIES in Lehm, Pl. Preiss, vol. ii., pp. 130-140 (1846).

BERKELEY in Hooker's Flora of Tasmania, vol. ii., pp. 241-282, plates 183-184 (1860).

KALCHBRENNER and DE THUEMEN in "Grevillea," vol. iv., pp. 70-76 (1876) ; and in Flora ephemer, Ratisbon, No. 28 (1878).

An enumeration of the lichens in the British Museum, which were collected in 1802-5, during the notable voyage of Flinders around these shores, is published in the Proceedings of the Linnean Society, London, for 1879.

The literature of Australian Miocene Palæontology has been enriched by the publication of two papers by the Rev. J. E. T. Woods, describing some fossils from the Muddy Creek beds. See Proc. Linn. Soc., N. S. Wales, vol. iii., pp. 222-240, plates 20, 21 ; and vol. iv., pp. 1-20, plates 1-4, 1879. The number of species figured and diagnosed is 59 gasteropods and three bivalves.

A few of the more remarkable and larger species from the Victorian Miocene are dealt with in Decade VI., Pal. of Victoria, by Prof. McCoy; these are *Lovenia Forbesi*, *Monostychia australis*, and the new species, *Clypeaster Gippslandicus* and *Hinnites Corioensis.* The same fasiculus contains the descriptions of three species of Cetotolites, or ear-bones of whales, probably *Ziphioid*, and other cetacean remains. These discoveries are interesting in connection with the presence of *balænoid* whales in the Murray beds, remains of which, including a perfect skull and a lower jaw, form part of the University collection.

# OUR CLIMATE AND INFANT MORTALITY.

By S. J. MAGAREY, M.B.

My apology for bringing the subject of infant mortality before the notice of the Society so shortly after the recent discussion on the subject is that I do not think that sufficient attention has been directed to the climate as the cause of the excess of mortality in this colony. I propose to consider the question by means of the light supplied by statistics kindly furnished me by Mr. Todd, the Government Astronomer, and Mr. Cleland, of the General Registry Office. I propose to compare the variations of the deathrate with the variations of the temperature, rainfall, barometric pressure, evaporation, and humidity during the years 1873-1877, both inclusive, these being the only ones that afford the material for so critical an examination.

In connection with the subject of infant mortality several questions have been propounded:—

1. Is the deathrate of infants higher in South Australia than it is in the other colonies?
2. Granted that the rate is excessive, can any reason be assigned for this excess?
3. Is this excess peculiar to Adelaide, or does it extend to the colony generally?
4. What means can be adopted to reduce this waste of human life?

Before proceeding to consider the several propositions set forth, it is well first of all to observe that in 1874 and 1875 we were visited with a severe epidemic of measles which carried off 355 persons, 127 of whom were infants. This epidemic was closely followed by a severe one of scarlatina, which destroyed 484 persons, 58 of whom were infants. On this account, and remembering, too, that a period of five years is a short one from which to draw reliable conclusions, I expect to find that these conclusions will have to be somewhat modified as the data become more abundant and reliable; but as these researches seem to give us a clue as to the best means of combating the more serious diseases of infant life, I submit my results without hesitation, holding myself in readiness to modify them if it should seem to be necessary to do so.

## I.—Is the Deathrate of Infants Higher in South Australia than it is in the other Colonies?

Dr. J. D. Thomas, at our recent discussion upon the subject, affirmed that the South Australian rate is often exceeded in other countries.

With regard to its relation to that of the other colonies, I have not been able to glean any information beyond that supplied by Mr. Hayter, in the "Victorian Year-Book for 1876."

From this it would appear that the infant deathrate per 1,000 births was—In Tasmania, 101; New Zealand, 102; New South Wales, 104; Queensland, 124; Victoria, 126; and South Australia, 156.

The rate here is higher than that of the other colonies, being half as much again as either that of New Zealand, Tasmania, or New South Wales. Allow me, however, to draw attention to one other fact, that is, the healthiness of South Australia for adults. I find in the same year-book the relative deathrates per thousand of the whole population of the various colonies thus tabled:—New Zealand, 12·7; Tasmania, 14·6; South Australia, 15·2; New South Wales, 15·4; Victoria, 15·9; Queensland, 18·2.

But I find after deducting from the total number of deaths of all ages those occurring under one year, that with regard to the rate of those *over* one year of age, the colonies stand in the following relative position:—New Zealand, 9·5; South Australia, 10·9; Victoria, 12·3; New South Wales, 12·6; Tasmania, 14·0; Queensland, 14·6. So that in the four years to the statistics of which I am able to refer, there is for those over one year of age only one colony more healthy than South Australia —viz., New Zealand—and that this colony is considerably more healthy than Victoria, New South Wales, Tasmania, and Queensland. Tasmania, which seems to be an unusually healthy colony for children, seems to be an unusually unhealthy one for adults, being almost as bad as tropical Queensland.

It is some consolation to know that if we can discover some means of getting infants through the first year or two of their lives, we are able to afford them a better chance of living to a good old age than any of the other colonies, with one exception, are able to do. I am, however, of opinion that the deathrate of 156 per thousand will prove higher than the average; for in three years out of the five it was lower than this—*e.g.*, in 1873 it was 140; in 1876, 149; and 1877, 140. It was the before-mentioned epidemics that raised the rate to such a height, it being in 1874, 171; and in 1875, 181. I think it probable that this epidemic of measles, coming as it did in the summer time, was more fatal than it was in the other colonies, which, I believe, it also visited.

## II.—Granting that the Rate is Excessive, can any Reason be Assigned for this Excess?

Care must be taken not to ascribe our high deathrate to general causes which are operating in other colonies and countries without producing evidence to show that these causes are more active and potential with us. We may attribute it to dry nursing, improper dieting, disproportionate ages in parents, too early or too late marriages, parental carelessness and intemperance, parental ignorance and wickedness, stupidity of nurses, the *nimia diligentia medicorum*, or even to high doctors' fees; but unless we prove that these causes are more active and rampant here than elsewhere, we shall not clear matters very much.

Dr. McCarthy, in a paper read before the Medical Society of Victoria in 1864, drew attention to the high rate of infant mortality in that colony, and although he noticed that more than half the deaths of those under five years occurred in four summer months, he attributed nothing to the Victorian climate, but in a singularly weak way ascribed this excess to careless dieting, improper clothing, impure air, and, as he was speaking to a Medical Society, he emphasized the want of early and sufficient medical attendance, and that fatal proclivity that people have for securing the attendance of quacks and heterodox practitioners. But as he afterwards asserts that for sixteen years he began the treatment of nearly all diseases of infants with emetics, many people will be inclined to think that if his treatment were adopted by the members of the Society he was addressing, they could not delay too long in sending for this so-called skilled medical attendance.

There is not the least doubt that all these causes co-operate to destroy children, and in the case of improper dieting, it may be that the effects of improper feeding may be more marked in our hot climate where there is in early life so much tendency to gastric disturbance. Still, it is the duty of those that ascribe our high deathrate to these causes to prove that these causes are more active in this colony.

Bad drainage, again, undoubtedly has an injurious effect upon infant life, and in no other way can the high deathrate in the mining districts, in Hindmarsh, and in Port Adelaide be accounted for. But seeing that many country places are nearly as destructive to infant life as these badly-drained centres of population, and seeing that the babies die in weather that seems to be suitable to healthy adult life, I believe that time will show that bad drainage is not so efficient a cause as heat, and that though its influence is to destroy life, yet we must go beyond it to discover the true cause of our excessive mortality.

*The* CAUSE of our excessive infant mortality I conceive to be

OUR CLIMATE—the hot dry air of our long South Australian summer.

Of the total number of deaths of infants in the province, the following proportions occur in the several months:—Most in March, 12·4; December, 12·1; January, 11·3; February, 10·8; April, 10·3; May, 8·3; November, 7; August, 5·8; June, 5·7; October, 5·5; September, 5·5; July, 5·3.

Five summer months head the list and five winter ones close it. As many babies die in four summer months—viz., January, February, March, and December—as in seven others. Twice as many die in January, February, March, and December as in June, July, September, and October.

Comparing the mortality with the temperature, we find the highest average temperature is in January. In this month the mortality is extremely high. In February both the temperature and mortality are slightly less. In March, the temperature is a little lower, whilst the rate of infant mortality attains its highest point. This must be either because the long-continued heat has worn the children out so that they cannot withstand the March temperature, or because the houses have become so thoroughly heated that though the air is not quite so hot, the temperature inside the houses and to which the infants are exposed, is just as high and even more close and oppressive.

From March, the temperature falls very rapidly during April, May, and June, and reaches its lowest point in July, and as it falls the rate of infant mortality follows *pari passu* in a remarkable way. It also reaches its lowest point in July.

In August, the temperature rises a little, and with it rises the rate of mortality. In September and October the temperature still slowly rises, but the rate of mortality remains almost stationary and not at all excessive.

In November and December, the temperature increases very rapidly, and with it the deathrate increases by "leaps and bounds," and in December becomes very high indeed.

From this sketch we conclude that the rate of mortality depends to a very large extent upon the height of the thermometer, and this with a regularity that is quite surprising, and to my mind proves that (excluding epidemics) the height of the thermometer during any given year will be the guide as to the amount of danger to which infants are exposed, provided that we make allowance for the humidity of the atmosphere. It is also noticeable that the thermometer begins to fall a little before the deathrate; it passes, but leaves a dreadful train to follow, and it begins to rise again a little before the deathrate increases, but as it rises the deathrate soon follows, showing that it is not exactly heat that kills, but continued heat.

WITH RESPECT TO HUMIDITY.—Upon this diagram I have the line of humidity drawn alongside the others (in this case reversed) in order to show that whenever it is hot it is dry. The line of temperature and that of humidity (reversed) you will observe scarcely part, showing that the heat of our colony is almost invariably a dry heat, and that our cooler months are almost invariably moist—in this respect contrasting with Queensland. The hottest month is one of the driest, and the coolest is the most moist. The healthiest month is the most humid month, and the driest month is the most unhealthy.

Rainfall.—I do not find that the rainfall, except in so far as it influences the humidity of the atmosphere, has much to do with the question of mortality.

Evaporation.—The only thing to notice is that the line of evaporation follows so closely that of temperature that no evidence can be obtained from it specially.

Barometric Pressure.—The healthiest months in the year for infants are as a rule those in which the barometer ranges the highest. The line of barometric pressure seems to follow somewhat closely that of temperature and humidity. When it varies considerably from these, as in March, April, and May, the line of infant mortality seems to follow that of temperature in preference.

Another most interesting conclusion I arrived at in the following way:—After calculating the deathrate for each month for infants, I did the same for children over one and under five years of age, and also for those over five years of age. I find that March proves most fatal to infants, December to children, and May to adults. February is very fatal to infants, much less so to children, and it is the healthiest month in the year for adults. The healthiest month in the year for infants is July, for children August, and for adults February.

The deathrate of *infants* seems to follow the line of temperature and humidity throughout the year; that of *children* seems to be still influenced by the temperature, being at its highest point in summer and its lowest in winter; but it is not nearly so much influenced in this way as that of infants, whilst the rate of mortality in adults seems to vary but little during the year and attains the *lowest* point in the summer time.

These observations seem to point out that the generally accepted statement that our summer with its hot winds is healthy, is to be understood as referring only to adults, for whilst the healthiest time of the year for adults is summer, young children suffer more from it, and in the case of infants it causes a perfect slaughter amongst them. If it be objected that we are speaking of summer and not of hot winds, the answer is that hot winds are dry, and it is the heat and dryness that causes the mortality. If our summer temperature could be reduced to that of October (say 62 deg.) in the four summer months December, January, February, and March, no less than 300 lives might annually be saved. "A shipload of immigrants of the best type and not of the criminal class."

I have stated that the heat of South Australia is always a *dry* heat, and that this is the cause of our excessive mortality. This will appear more distinctly by comparing it with that of Queensland. In that colony the deathrate of infants is much lower than it is in South Australia, although the temperature of Queensland is some five or six degrees higher. But in Queensland there is a great deal more moisture in the atmosphere. Taking for example the year 1875, we find that the average temperature for that year in South Australia was 62·1—that of Queensland 69·3; the infant deathrate of South Australia was 181 per 1,000, that of Queensland only 152. Hence though the temperature was seven degrees more, the deathrate was 29 per 1,000 less. But the amount of humidity in Queensland was 77, while that of South Australia was only 60. And this difference in the amount of humidity is more marked in the summer months than in the year's average. In the four summer months January, February, March, and December, in 1875, the degree of humidity in South Australia was 43 per cent. less than that of Queensland, whilst its temperature was only 8 per cent. less. This certainly shows that it is not the fact of its being hot alone that destroys children, but that the heat is complicated with dryness.

### III.—Is the Deathrate of Infants Higher in Adelaide than in the Colony generally?

The rate in the City of Adelaide is 216 per 1,000 births.
" " of the District of Adelaide is 176·7 " "
That of the colony, excluding Adelaide, 148 " "

In other words, nearly 50 per cent. more deaths occur in Adelaide in proportion to the infant population than in the rest of the colony. The deathrate of infants in the City of Adelaide as in the Province seems very closely to follow the line of temperature and humidity, but the most fatal month is not March but December, which is also the month in which there is the least humidity. The healthiest month is July, but the rate of mortality is higher in August than that of the Province seems to be. There are, however, two districts even more unhealthy for infants than Adelaide, viz., the District of Daly, including Wallaroo and Moonta, and that of Hindmarsh. In these two districts as many as 230 children in every 1,000 born die before they reach the age of one year. After these comes Port Adelaide with a deathrate of 180·6; then the District of Adelaide, 176·7; Mount Barker, 160·7; Burra, 155·6; Frome, 154·7; Kapunda, 148·4; Clare, 141·3; Highercombe, 129; Port Gawler, 128·2; Crawford, 128·2; Barossa, 124·8; Gilbert, 121; Strathalbyn, 118·4; Wellington, 109·2; Grey, 104·7; Robe, 104·3; Talunga, 103·2; Flinders, 101·5; Upper Wakefield, 101·4; Willunga, 100; Angaston, 95·9; Nairne, 94.8; Encounter Bay, 94·7; Morphett Vale, 86·3; and, lastly, Yankalilla, including Kangaroo Island, only 65.

As a general rule we find that the more we go to the north the higher is the deathrate of infants, the only exception being in crowded centres of population. Why the Districts of Daly, Hindmarsh, and Port Adelaide should be so fatal I cannot explain, unless the blame be laid upon the wretched drainage in these places. The most healthy district is Yankalilla and Kangaroo Island, and around the mouth of the Murray. I am not sure that we make enough use of Kangaroo Island as a health resort in summer time. Strange to say the mortality in the Mount Barker district is 160·7, while that of the District of Nairne, adjoining, is only 94·8. Perhaps more die in the winter in Mount Barker. I cannot find any means of deciding this point. Of all the districts north of Adelaide that of Angaston is the most healthy.

## IV.—Can any Means be Adopted to Reduce this Excessive Infant Mortality?

This subject has already been fully discussed, and hence I shall be very brief. We have had suggestions by able men, given in lectures to the people, which, if they were acted upon, would much tend to reduce the rate, more particularly as regards the dieting, clothing, &c., and improvement of the homes. But if our babies die because the air is too hot and dry, we must modify our treatment accordingly, and I shall merely press this point briefly.

During the hot days every care should be taken to counteract the influence of this hot dry atmosphere. When the baby is ill it is the height of folly to throw open the door and window on an Australian summer's day to let in the hot wind under the erroneous impression that it is healthy. On the contrary by every possible means keep the air in your rooms cool. We cannot reduce the temperature of the colony, but we can reduce that to which our infants are exposed. Many ways suggest themselves at once for doing this, only one or two shall we notice.

A baby with little or no clothes on has a much better chance of living through a week of hot summer's weather than one "properly dressed." Too many clothes are put upon the child. The child could then be bathed two or three times a day in tepid or cold water without trouble. The child's head should always be uncovered when it is in the house. These are but a few examples of the sort of treatment required to meet the case, but as I am not trying to write a popular lecture I leave many other points unmentioned.

But the main remedy, to my mind, is wherever practicable to spend the hot days, and if necessary the hot nights, in *underground* rooms. A reduction of temperature varying from ten to more degrees can be obtained by this means. I have often seen lives saved by this plan. It may be objected that as we have not deep drainage these rooms will be damp and unhealthy. No doubt to a certain extent they will be so, but you are flying from a great danger, and it is rational to risk a smaller one for safety. When we have deep drainage this objection will be removed. If it can be proved that by removing children to a cool temperature we can save their lives in summer, it is to be hoped the day is not far distant when benevolent persons will cause large, well-ventilated, cool resorts to be built in this city, to which babies may be taken during the heat of the day The place might be made attractive with fountains, flowers, &c. The wonder is that infants can last a single day in the miserable tenements of the poor in this city—the heat in them is often so intense.

As I do not wish to write a paper upon treatment, I shall conclude by noticing an argument that was supported by several medical men at our last discussion upon the subject. This was that the babies died because they could not perspire. The heat became intense, and a large amount of heat was absorbed, and as none of it could be rendered latent by the process of perspiration (as in adults) the blood became too hot to be compatible with the preservation of life. Now, I have been unable to discover any proof that infants do not perspire. 2nd. I have often seen them covered with perspiration; and, 3rd, the wonder is that any one could imagine that the process of perspiration could be suspended in a healthy subject, seeing that the sudoriparous glands are fully developed, the skin is soft, and the blood supply complete. It seems more probable that this heat acts directly upon the nervous system. It causes what has been called fluxionary hyperæmia of the brain, with consequent disordered function, and leading to the establishment of fatal forms of brain disease.

Again, by depressing the sympathetic and other ganglia, it arrests or causes the disorder of, secretion of various glands. In consequence of this the food taken is undigested and vomited, or passing into the bowels causes that diarrhœa which is the most obstinate of summer diseases to treat. The essence of all is *depression.* Hence so many deaths are ascribed to "atrophy and debility"—terms that should not, if possible, be entered upon a certificate of death, and yet terms that are very expressive of the type of disease that has caused the necessity for a certificate.

If I have proved that the hot, dry air of our climate is the cause of the excessive mortality of infants in this colony my object has been attained, for I conceive that if this view be correct the first thing is to recognise it; and having recognised it, we shall be led to discover and to adopt measures that will be efficient in counteracting its influence. It is a subject of vast importance, and for this reason only am I justified in inflicting so many dry facts upon you.

# AVERAGES (MONTHLY)

## From 1873-1877 (inclusive).

| | Deaths of Infants in South Australia. | | Deaths of Children in South Australia under 5 years and over 1 year. | | Deaths over 5 years in South Australia. | | Deaths of Infants in City of Adelaide. | | Barometer. | Temperature | Evaporation | Humidity. | Rainfall. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total each month for 5 years. | Percentage per month. | Total each month for 5 years. | Percentage per month. | Total each month for 5 years. | Percentage per month. | Total each month for 5 years. | Percentage per month. | | | | | |
| Jan. ... | 685 | 11·3 | 205 | 8·2 | 136 | 8·1 | 137 | 12·8 | 29·816 | 74 | 10·885 | 48·3 | ·367 |
| Feb. ... | 659 | 10·8 | 201 | 8 | 121 | 7·2 | 138 | 12·8 | 29·873 | 72·7 | 8·557 | 49.8 | 1·266 |
| March . | 756 | 12·4 | 252 | 10·2 | 150 | 8·9 | 140 | 13 | 29·968 | 69·7 | 7·105 | 52 | 1·373 |
| April ... | 629 | 10·3 | 247 | 9·9 | 149 | 8·9 | 78 | 7·2 | 30·007 | 63·7 | 4·383 | 61·4 | 2·025 |
| May ... | 505 | 8·3 | 198 | 8 | 154 | 9·2 | 66 | 6 | 29·964 | 56·9 | 2·841 | 70·6 | 4·137 |
| June ... | 349 | 5·7 | 211 | 8·5 | 137 | 8.2 | 59 | 5·5 | 30·054 | 52·7 | 1·703 | 74·8 | 2·173 |
| July ... | 324 | 5·3 | 190 | 7·6 | 137 | 8·2 | 40 | 3·7 | 30·144 | 50·4 | 1·745 | 76·4 | 1·980 |
| Aug. ... | 354 | 5·8 | 165 | 6·6 | 150 | 8·9 | 75 | 6·9 | 30·001 | 53·9 | 2·674 | 71·2 | 2·499 |
| Sept. ... | 334 | 5·5 | 169 | 6·8 | 132 | 7·8 | 54 | 5 | 29·974 | 55·6 | 3·487 | 67·2 | 2·067 |
| Oct. ... | 337 | 5·5 | 200 | 8 | 135 | 8·1 | 53 | 4·9 | 29·936 | 62·2 | 5:938 | 58·4 | 1·653 |
| Nov. ... | 425 | 7 | 193 | 7·7 | 136 | 8·1 | 75 | 6·9 | 29·869 | 64 | 7·593 | 52·8 | ·662 |
| Dec. ... | 735 | 12·1 | 262 | 10·5 | 141 | 8·4 | 165 | 15·3 | 29·842 | 71·3 | 10·243 | 46·6 | ·934 |
| Total . | 6,092 | | 2,493 | | 1,678 | | 1,080 | | | | | | |

# The South Australian Statistics of Consumption.

By Joseph C. Verco, M.D.

It has long been known that the prevalence and fatality of consumption of the lungs vary greatly at different places and under different climates. But there does not seem to be any one climate which specially opposes the disease. It has been shown to be almost unknown in some of the cold and stormy islands off the western coast of Scotland. The number of invalids with pulmonary affection who yearly flock to the temperate regions of Italy and Southern France testify to the popularity of the impression that a mild, genial atmosphere is highly beneficial. Yet our southern sub-tropical colony does not fail to attract a host of sufferers seeking amidst all the discomforts of dry and dusty heat the cure for their complaint, while there are not wanting those who extol the rarified and bracing air of lofty mountain chains as *par excellence* the remedy for phthisis. It would appear, then, to be almost impossible to decide from the physical or meteorological data of a given locality whether it would prove beneficial or otherwise. A guess might be made either right or wrong. The appeal must be made to the statistics of the place; whatever the *à priori* conclusion may be, the real decision must rest upon the death returns. In spite of all we hear in depreciation of statistics to the effect that anything may be proved from them, it is certain that very little could be proved without them—all that could exist would be a mere floating, unsatisfactory general impression. I wish to point out what, that is fairly definite, can be learned about consumption in South Australia from this source.

Where the materials from which deductions are to be drawn respecting a complaint consist entirely of death returns, the study of phthisis presents an advantage over that of almost every other affection, viz., that so large a proportion of the patients attacked ultimately die from its ravages. I would not be understood to suggest that it is incurable—it most certainly *is* curable; still so many of those seized are eventually destroyed, that the mortality tables give a very approximate idea of the prevalence of the disease.

It is only during the last five years that the annual returns of vital statistics have been issued in their present fulness; so that it is to these five years—1873-77—that our attention must be confined, and from which our deductions must be drawn. Because our community is so small, numbering less than a quarter of a million persons, and because the reports extend over so few years, it may be suggested that the figures are not large enough to permit of any very certain conclusions, inasmuch as a few exceptional cases might lead to generalizations, which but for these stray cases would wear a very different complexion. Without doubt this may be in degree true. But these statistics constitute almost all the material at present at our disposal; and we must be content to reduce them, if we would learn anything about the disease as it now exists; and leave the confirmation or disproval of our conclusions until our population and our returns furnish us with more extensive data. There are several points, too, which seem plain and prominent on the very face of our statistics; and it is quite improbable that future returns will prove them temporary or circumstantial.

Because our attention will be almost wholly confined to these reports, we shall be unable to touch upon many questions of interest, much less to decide them; since no hint respecting them is contained in our tables. For example, of what moment would it be to determine whether the acclimatised immigrant is more predisposed to the disease than the native-born South Australian; whether the natives of the second generation are more liable than their parents; whether, in fact, the South Australian race is becoming more obnoxious to it, and in that sense is constitutionally degenerating, or is acquiring a resisting power, and so developing. In the death certificates provided by Government for the use of medical men, there is provision made for obtaining the information requisite to decide the first query. But no return founded upon this information is issued, owing, I believe, to the fact that the information is not supplied by the medical men. Now, it will be seen as we proceed that more than one question of great importance might be satisfactorily replied to did we know how long the deceased had been in the colony. This is the point on which we require and might have had returns, on which it was intended we should have had—as witnesseth the blank space in the death certificate.

## Extent of the Disease.

The first question that naturally arises is to what extent does consumption prevail in South Australia, and how does the mortality here compare with that elsewhere? During the five years 1873-77, 969 deaths have occurred in the province. Estimating the population at 210,516, the mean for the five years, we obtain an annual deathrate of ·920 per 1,000 for both sexes at all ages.

From the Thirty-ninth Annual Report of the Registrar-General of England we learn that the deathrate from consumption, during the twenty-five years 1850-74, was 2·5672 per 1,000; and during the five years 1870-74, 2·2828 per 1,000. So that the mortality there is from 2½ to 2¾ times greater than here. This is a result highly favourable to our colony, and proves that there are in South Australia certain circumstances which do not exist in England, or exist in much smaller degree, and which confer upon the people some sort of immunity from this affection. Whether those circumstances are the healthier constitutions of the earlier settlers and the later immigrants, the absence of overcrowding and poverty, the larger proportion of agriculturists, certain social or moral conditions, or climatic influences, we cannot just now stop to inquire. We simply state the fact that the deathrate in England from phthisis is from 2½ to 2¾ times higher than here. Our statistics, then,

---

| | | | |
|---|---|---|---|
| 1873 .. .. .. .. | 198,257 | 153 | ·77 |
| 1874 .. .. .. .. | 204,883 | 179 | ·87 |
| 1875 .. .. .. .. | 210,699 | 208 | ·99 |
| 1876 .. .. .. .. | 224,488 | 226 | 1·00 |
| 1877 .. .. .. .. | 236,864 | 203 | ·86 |
| | 1,075,191 | 969 | ·898 |

This table gives the estimated population of South Australia of both sexes on the 31st of December of each year, the absolute number of deaths from phthisis, and the rate of mortality to 1,000 of living persons. The annual rate, the mean of the five years, is ·898. As the population reckoned here is that of the *last day* in each year, and as this is greater than the mean population for the year, it is evident that the deathrate from consumption is slightly lower than it should be. To be as accurate as possible strike the mean between the population on the 31st of December for each year and that of the last day of the previous year, and take this as the more approximate population. For 1873, suppose an increase during this year equal to that of 1874, viz., 6,626, and subtract the half of this amount—3,313—from 198,257, the population of December 31st, 1873.

| | |
|---|---|
| 1873 .. .. .. .. .. .. .. | 194,944 |
| 1874 .. .. .. .. .. .. .. | 201,578 |
| 1875 .. .. .. .. .. .. .. | 207,791 |
| 1876 .. .. .. .. .. .. .. | 217,598 |
| 1877 .. .. .. .. .. .. .. | 230,676 |
| | 1,052,579 |

The total population for the five years is thus reduced from 1,075,191 to 1,052,579, and the deaths remaining the same, the rate per 1,000 of the people is raised from ·898 to ·920. This may be considered as approximate an estimate as can be obtained of the mortality from phthisis in South Australia—·920 per 1,000 for both sexes, at all ages, throughout the province.

support strongly the general impression afloat that South Australia is a very favourable place for those who are predisposed to this disease, and negative such assertions as that phthisis "is very common and malignant in the South Sea Islands, Australia, and New Zealand,"* at least when the comparison is with its prevalence and fatality in England.

Is South Australia thus comparatively free from consumption *alone*, or is there the same proportional freedom from disease as a whole? It is of course conceivable that there might be certain conditions antagonistic to disease generally, and not to phthisis specially. If this were the case, then on comparing the deaths from consumption here with those from all diseases, the ratio would be the same as that of the phthisis mortality to the total mortality of England. If, on the other hand, there were in South Australia a special immunity from this affection, then the ratio here should be less than that at home. And so it is. During the seven years 1871-77, the ratio of the deaths from consumption to those from all diseases was 5·764 per cent., while the English returns show the proportion of 10·2 per cent. Hence, we conclude that in South Australia there is a special immunity from phthisis as compared with all other disease; that there are certain conditions which exert an influence twice as favourable to life in the case of consumption as in other disease; that South Australia is a residence specially for those of consumptive tendencies.

Perhaps the most important inquiry that arises among the many regarding our mortality from consumption is this—Is the deathrate rising or falling in South Australia? Is the above shown favourable state of affairs merely temporary, or have we ground for hoping that our mortality may remain permanently low, or even be reduced? This question becomes more interesting from the fact that may be observed in the

| | | | |
|---|---|---|---|
| 1871 | 157 | 2,378 | 1 in 15 |
| 1872 | 146 | 2,896 | " 19·8 |
| 1873 | 153 | 2,631 | " 17·19 |
| 1874 | 179 | 3,406 | " 19 |
| 1875 | 208 | 4,136 | " 19·8 |
| 1876 | 226 | 3,550 | " 15·7 |
| 1877 | 203 | 3,225 | " 15·9 |
| | 1,272 | 22,222 | " 17·35 |

This table gives for seven years the number of deaths from phthisis of both sexes and all ages, the number of deaths from all diseases, and the ratio which those bear to these. The result is 1 in 17·35, or 5·764 per cent. The English returns for 1876 show that 49,795 persons died of consumption and 510,315 from all diseases; so that 10·2 per cent. were accounted for by this complaint.

* Hirsch, cited in Waters's "Diseases of the Chest," page 223.

English returns. These make it evident that for the last five-and-twenty years the deathrate from consumption has steadily decreased during every quinquennium from 2·8112 for 1850-54 to 2·2828 for 1870-74. By some means, either municipal hygienic measures, or personal, direct medical treatment, or otherwise, fewer persons, proportionally to the population, are dying of phthisis than formerly in England.

In England, the deaths were per 1,000 from phthisis—2·8112 for 1850-54, 2·6476 for 1855-59, 2·5664 for 1860-64, 2·5278 for 1865-69, 2·2828 for 1870-74.

What is the state of affairs amongst us? Had the statistics been investigated at the end of 1876, one would have been inclined—would have been forced—to admit the very disagreeable fact that the rate was rising so rapidly as to be quite alarming, and so steadily as to furnish ground for fear that at no very distant date it would even reach that of the countries at the antipodes. Not only have the deaths been increasing yearly with the increase of population, but out of proportion to it; so that the mortality from 1873 to 1876 has risen from ·77, through ·87, ·99 to 1·00 per 1,000.

However, in 1877, although the population had increased by 12,000 souls, the deaths from phthisis had absolutely diminished, and were even fewer than in 1875, when the population was less by more than 24,000 persons. The ratio for the year was thus reduced again to that of 1874. This circumstance might have encouraged us to hope that the steadily-increasing mortality of the previous four years was but temporary, and did not indicate a rapid and continuous progress of this scourge of humanity. But I find from the monthly returns of 1878 that during that year there were 267 deaths from this complaint, while the population at the end of December, as nearly as I can calculate it from the monthly means, was about 250,000, which gives a deathrate for the year of about 1·067. This is higher than that of 1876, when it stood at 1·0067; higher, in fact, than in any other year of which I have returns. So that it would seem that the fall in 1877 was an exceptional circumstance, and that the hope excited by the low mortality of that year is completely dispelled by the returns for this; and we must, however we may account for it, reconcile ourselves to the uncomfortable fact that our mortality is increasing, and that it has increased to nearly half as much again as it was six years ago. This is brought into bolder relief by contrasting our rising deathrate with the falling mortality of England. How is this growing fatality to be explained? Surely our climate cannot be changing to such a degree as to account for the rise? Are South Australians degenerating to this extent? Are we importing a race of immigrants constitutionally so unsound? Are our sanitary arrangements becoming so exceedingly defective? Is our social or moral condition becoming so deteriorated? Or is it that the diminution in the mortality at home and its increase here are to be attributed to the increased facilities for travel, in consequence of which more invalids are yearly leaving the old country and seeking in climates accounted more favourable to their constitutions health and longer life. To this explanation, in part at any rate, I am inclined, viz., the exodus of the phthisical from England in search of cure, and the influx of such persons into our colony, not only as voyagers at their own expense, but as immigrants introduced by the Government. This is a matter that might be very approximately settled by a careful filling up of the space provided in the medical death certificates, whereby we should learn how long each individual had been in the colony, and how much of the mortality should be debited to South Australia, and how much to other countries. Until this question is decided, and unless this suggestion is confirmed, the prospect for the phthisical in South Australia is gloomy. A growing cloud threatens to obscure the brightness of our skies from which the consumptive has been accustomed to draw some rays of hope.

Having demonstrated above that fewer persons die of consumption here than in England, one is curious to know whether among consumptives life is lengthened in our colony or not. In England the mean duration of life among those who succumbed to this disease in 1876 was 33 years and 2 months. In South Australia during the five years it was 31 years and 10 months. The difference is in favour of England to the extent of one year and four months. It appears, then,

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The mean duration of life has been thus calculated:—In England 1,242 males died under 5 years of age. It would be manifestly wrong to consider them as all dying at five; this would give too high a mean, so it is taken at 2½. The 1,242 then lived a total of 3,105 years. 418 died between 5 and 10; their average was 7½; their total age 3,135, and so on. Accordingly the years lived by the males and females who died of phthisis in England in 1876 are as under:—

| | | | |
|---|---|---|---|
| 25,127 males | lived 872,736 | years, or | 34 yrs. 7 mos. per m. |
| 24,668 females | " 777,691 | " " | 31 yrs. 1 mo. " f. |
| 49,795 both sexes | 1,650,427 | " " | 33 yrs. 2 mos. |

In South Australia the totals are as follows:—

| | | | |
|---|---|---|---|
| 517 males | lived 17,691 | years, or | 34 years 3 mos. per m. |
| 450 females | " 13,009 | " " | 28 years 11 mos. " f. |
| 967 both sexes | 30,691 | " " | 31 years 9 months. |

When grouped together in the same periods as the English deaths the mean age for both sexes is found to be 31 years 10 months.

that phthisical patients out here not only do not live longer than they do there—they do not live so long. Now, here we require to be careful in the use of words, so as not to mislead or to be misled. We ought, perhaps, to say "they do not live to be so old," because the matter involved really is the duration of life, and not the duration of disease. Those who die out here of phthisis do not live to be so old as those who die of consumption at home. This is due, evidently, to one or two circumstances. Either with the same average age at which people are attacked the disease is more rapid and kills sooner out here, and so the duration of the disease and hence of life is less, or else with the same malignity of disease the people who are attacked out here are younger. Which of the two is it? As to the average duration of the disease, we can learn nothing from our statistics. The popular impression and that of the faculty is that people with this disease at least prolong their days by leaving England, taking a voyage to Australia, and remaining here. But if their life is really extended and they eventually succumb, then the mean duration of life here ought to be greater than in England, where they would have died by so much the sooner as their days have been prolonged by the change. But our mean duration is actually less; therefore, either life is not lengthened in those who come out with the disease, or their prolongation of life is more than counterbalanced by the other early deaths out here. So we have to come back to the disease as it begins in South Australia, and face this difficulty "that people die of consumption at an earlier age here than in England"—a difficulty increased by the probability founded on popular and medical belief that people who come here with the disease have their life prolonged. Either the people attacked out here are younger than in England, or else the disease is more rapid and malignant. Whether the disease is more rapid or not, our statistics cannot inform us. This the doctors must tell us from a reduction of their private notes. Does it attack the people at an earlier age? Our tables show only the age at death, and not at the commencement of the disease. May it be that the disease does not attack the people at an earlier age than in England, but that the people to be attacked are not so old in South Australia. This would explain the difficulty. For if our population consisted mostly of young people, and the English of much older persons, even though the disease attacked the people living of the same ages in an equal degree there and here, and the duration of the affection were the same in the two instances, yet the mean age of death would, of course, be less in South Australia than in England. If we take the census of 1876 as a basis we find our average age to be more than four years less than that of the persons living in England in 1876. Our colony is very young, not fifty years of age: our community is young, time has not been allowed even for our early settlers to attain to extreme years. There is a constant immigration of persons, none of whom are above forty years of age, and so it comes to pass that our mean age is four years less than that of the mother country. But the shorter duration of life is only one year and four months. So we may believe that this is fully explained by that, and more than explained; and that although our mean duration of life in those who die of phthisis is sixteen months less than at home, yet it is quite possible, nevertheless, that we may be attacked at a later rather than an earlier age, and our duration of life after invasion, both among those who are attacked here and those who contract the complaint elsewhere, may be longer than in England. There is one other circumstance which may be mentioned, too, by way of explanation and palliation of our lower age at death. It is this:—There is confessedly considerable immigration of people in the early stages of consumption from Britain to these colonies. These come out here and die. Now it seems very natural that these should consist almost entirely of the young. For when men have attained to middle age they are engaged in business pursuits which to leave would be to ruin, or are surrounded by families, to whom domestic necessities and domestic affections inseparably bind them. But the young, more sanguine of benefit than the old, more attracted by the novelty of travel, less fettered by business and by family ties, find it more convenient and congenial to take the voyage. They come out here, and they die. The older die at home. These raise the mean duration of life in phthisis in England—those lower it in South Australia. Again we require the blank space filled up in our death certificates, that we may know among those who die at early ages, how long they have been in the colony.

### Influence of Season.

If we prepare a table showing the number of deaths which have occurred during each of the twelve months of the years 1872-77 we find that in January 84 died, in February 71, in March 102, in April 113, in May 102, in June 85, in July 89, in August 102, in September 93, in October 105, in November 90, and in December 77. Whence it appears that the fewest deaths during any three consecutive months occurred in December, January, and February, with a total of 232; most deaths in the next three months of March, April, and May, viz., 317; during the next quarter, June, July, and August, the total is 276, and during September, October, and November 288. The hottest three months in our year are December, January, and February, the coldest three June, July, and August, while the other quarters are intermediate in their temperature. Therefore the smallest number of deaths occur during the hottest three months, our summer; the next smallest during the coldest threé, our winter; then during the three spring months; and the largest number during the three autumn months. So it seems that our southern summer, with its heat, is by no means inimical to the phthisical patient, but manifestly beneficial; that the settled cold of our winter is not to any great degree unfriendly; that the seasons most to be dreaded are the milder ones, the transition periods; and that the quarter of falling temperature, the autumn, is more disastrous than the spring, with its gradually increasing heat. Now this, I imagine, though it must accord with the experience of medical men—for our statistics are but the embodiment of such experience—is almost the reverse of what we should have been inclined to prophesy. We should have anticipated that

DEATHS FROM PHTHISIS IN SOUTH AUSTRALIA IN THE 12 MONTHS.

| | Jan. | Feb. | March | April. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1871 .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 10 |
| 1872 .. .. | 13 | 8 | 14 | 17 | 13 | 9 | 9 | 15 | 14 | 11 | 13 | 10 |
| 1873 .. .. | 13 | 14 | 15 | 7 | 16 | 8 | 13 | 18 | 13 | 19 | 13 | 4 |
| 1874 .. .. | 10 | 6 | 20 | 28 | 13 | 13 | 8 | 14 | 12 | 17 | 19 | 20 |
| 1875 .. .. | 16 | 16 | 19 | 25 | 18 | 18 | 14 | 20 | 16 | 15 | 15 | 16 |
| 1876 .. .. | 15 | 12 | 13 | 16 | 23 | 20 | 29 | 19 | 21 | 28 | 13 | 17 |
| 1877 .. .. | 17 | 15 | 21 | 20 | 19 | 17 | 16 | 16 | 17 | 15 | 17 | .. |
| Total .. | 84 | 71 | 102 | 113 | 102 | 85 | 89 | 102 | 93 | 105 | 90 | 77 |

DEATHS FROM ALL DISEASES IN SOUTH AUSTRALIA IN THE 12 MONTHS.

| | 1871. | 1872. | 1873. | 1874. | 1875. | 1876. | 1877. | Total. |
|---|---|---|---|---|---|---|---|---|
| January .. .. .. | .. | 284 | 269 | 237 | 461 | 264 | 339 | 1,854 |
| February .. .. .. | .. | 211 | 217 | 210 | 398 | 317 | 324 | 1,677 |
| March .. .. .. | .. | 323 | 276 | 298 | 495 | 325 | 367 | 2,084 |
| April .. .. .. .. | .. | 329 | 233 | 290 | 462 | 272 | 364 | 1,950 |
| May .. .. .. .. | .. | 254 | 225 | 280 | 402 | 286 | 282 | 1,729 |
| June .. .. .. .. | .. | 243 | 195 | 235 | 311 | 276 | 228 | 1,488 |
| July .. .. .. .. | .. | 215 | 212 | 177 | 290 | 322 | 199 | 1,415 |
| August .. .. .. | .. | 225 | 192 | 237 | 283 | 362 | 197 | 1,496 |
| September .. .. | .. | 184 | 208 | 251 | 255 | 256 | 196 | 1,350 |
| October .. .. .. | .. | 165 | 169 | 315 | 246 | 271 | 211 | 1,377 |
| November .. .. | .. | 216 | 184 | 385 | 274 | 246 | 235 | 1,540 |
| December.. .. .. | 222 | 247 | 251 | 546 | 259 | 353 | .. | 1,878 |

the genial autumn and spring would have been most beneficial, and the extreme seasons the most baneful. But so it is not. The hot, dry, dusty summer is the most propitious of all, and next our winter, with its sub-tropical rains.

Now it may be suggested that since this is a chronic and not an acute disease, although during the autumn the mortality is highest, this may be the effect of the excessive heat of summer; the effect not being perceptible until after the lapse of some months, because the heat does not kill the phthisical patient at once, but only after an interval. This suggestion is plausible, and moreover it derives no litttle support from the figures, for we might thus explain that it is not only the great heat of summer that produces the great mortality of autumn, but that the milder autumn weather accounts for the smaller deathrate of winter, the comparative severity of winter again the increased mortality of spring, and the genial influences of spring the minimum mortality of summer; allowing thus three months for the production of the effect by its cause. But although its ingenuity is attractive, this theory must not, I think, be entertained. Rather than receive it, we must lay the statistics aside, with the impression that we can come to no certain and definite conclusion about the influence of season. For how do we know what length of time must elapse before the deleterious influence acting on the phthinode will kill? Why should it be three months, and not six? Why should we suppose that the higher mortality of the autumn is the expression of the baneful influence of the summer, manifested after an interval of three months, rather than that the lower mortality of the winter is the expression of its beneficial influence visible after six months? No; unless we conclude that the small summer deathrate is due to the summer, we must abandon all conclusion on the effect of season. Did we find in reference to phthisis a state of things similar to what we observe in considering the question of infant mortality, we might admit the hypothesis perhaps. There we see the death-rate *increasing very rapidly* during the hot months of December, January, and February, to a high figure, but reaching the maximum only in March, when the temperature has begun to fall, and then decreasing as the heat continues to fall during the succeeding months. In such a case it is admissible as an explanation, and highly probable, that the maximum in March is the climax of the ill effects of the high temperature of December, January, and February, and is not due to the March temperature alone. But the case is very different in regard to consumption. If the summer influences were deleterious, we should at least expect that during the summer the deathrate would increase to some extent, even though it should reach its acme in the autumn. But the reverse takes place. During our quarter of extreme heat our deaths are fewest; therefore, we cannot suppose our summer is inimical, but friendly, to the patients, and must credit it with its own minimum mortality. And when we review the cases that have fallen under our notice, we must remember how these patients nearly always enjoy the hot weather more than any other season of the year, and require medical services less.

If we throw the monthly deaths from phthisis into the form of percentages, and so facilitate a comparison with the monthly mortality from all diseases, the special influence of the summer upon consumption becomes more evident.

208 per 1,000 of the deaths from phthisis occur in December, January, and February.

285 in March, April, and May;

248 in June, July, and August;

259 in September, October, and November.

273 per 1,000 of the deaths from all causes occur during December, January, and February;

290 during March, April, and May;

222 during June, July, and August;

225 during September, October, and November.

Whence it appears that the deaths from consumption are during the summer 8 per cent. less than during the autumn, 4 per cent. less than during the winter, and 5 per cent. less than during the spring. On the other hand the deaths from all causes during the summer are 2 per cent. less than during the autumn, 5 per cent. more than during the winter, and 6 per cent. more than during the spring. So we conclude that the summer weather, which is maleficial as regards disease in general, causing an increased mortality of 5 per cent. over that of winter, is beneficial—specially beneficial—in phthisis, causing a lowered deathrate of 4 per cent.

Can we explain to what this lower mortality in summer is due? Not altogether satisfactorily. May it be due to the heat? Probably to some—to a large extent. The fact that the minimum deathrate occurs in summer points to an antagonism between heat and phthisis. But heat will not wholly

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The mean monthly temperatures for the ten years 1865-74 are as follow, with the quarterly means:—

| Dec., Jan., Feb. | Mar., April., May. | June., July., Aug. | Sept., Oct., Nov. |
|---|---|---|---|
| 71·4 73·7 73·8 | 70·1 64·6 58·2 | 54·4 51·5 53·7 | 56·9 62·5 66·5 |
| 218·9 | 192·9 | 159·6 | 185·9 |
| 72·3 | 64·3 | 53.2 | 61.0 |

The quarterly deathrates from phthisis are—

| | | | |
|---|---|---|---|
| 208 | 285 | 248 | 259 |

account for the seasonal variations, inasmuch as the thermic chart does not indicate the same fluctuations. Although the minimum deathrate coincides with the maximum temperature for the quarter, that is the only correspondence—the minimum temperature does not coincide with the maximum deathrate, nor the falling and rising heats with increasing and decreasing rates. Therefore, heat alone will not explain the variations.

Nor will the rainfall, nor the humidity of the atmosphere, nor any combination of these, since they follow very closely the thermic curves, only in a reverse direction.

Nor will the diurnal range of temperature—the change that occurs from heat to cold daily—inasmuch as the mean monthly diurnal range corresponds with the ordinary temperature chart, being greatest in the hottest quarter, and *vice versa.*

One circumstance that I would suggest is the settled or unsettled state of the season. During the summer we experience a settled state of warm, dry weather. At this time we get the minimum of deaths. During the winter we have a settled state of much cooler wet weather, but not extremely cold. This is not so beneficial. During the autumn and the spring the weather is more fluctuating, days of great heat alternating with others of rain storms and much lower temperature. Now it seems very possible that these milder seasons, because they are so much more uncertain, may be those which, in advanced phthisis, produce such an exacerbation of the disease as is sufficient to cause death.

## Influence of Sex.

Has sex any influence upon phthisis in South Australia? Yes, in more respects than one.

1. As regards susceptibility to the disease, we find that during the five years there have occurred 517 deaths among males, and 450 among females. When we examine the proportion of men and women in our community we find that there are 449,633 males for every 417,859 females, or 517 men

The estimated populations in South Australia are as under:—

| | | | | | |
|---|---|---|---|---|---|
| 1873 | .. .. | 101,743 | males, and | 96,514 | females. |
| 1874 | .. .. | 104,995 | " | 99,888 | " |
| 1876 | .. .. | 116,503 | " | 107,985 | " |
| 1877 | .. .. | 126,392 | " | 113,472 | " |
| | | 449,633 | | 417,859 | |

In England in 1876 there was a population of 11,801,633 males and 12,442,377 females, while the deaths from phthisis were 25,127 males and 24,668 females. But if the deaths were proportional to the populations, 26,491 women ought to have died instead of 24,688, or 145 women instead of 135. So the populations being equal, 145 men die for every 135 women; or men are more susceptible to the extent of 1-13·5 part.

for every 480 women. Therefore, if consumption were equally an affection of both sexes, for every 517 males that die, there should be 480 females; but there are only 450. So that phthisis attacks men more frequently than women, according to the ratio 480 to 450, or 16 to 15. Men are to the extent of one-fifteenth part more liable to this disease than women. The same is found to be the case on application to the English statistics. In 1876, 145 men died for every 135 women; so that the mortality among males ruled higher by one-thirteenth to one-fourteenth part. This is not very different from the one-fifteenth part observed out here. It has been suggested by a writer (Dr. Bird) that this greater susceptibility of men influences the comparative deathrate in England and South Australia. For since men are more liable than women, that country where the men preponderate will, other circumstances being equal, show a heavier mortality. Now, whereas the males predominate in this colony, in the mother country the reverse occurs; and therefore in contrasting the climates in regard to their desirability in this disease, something should be subtracted from our mortality, or added to that of England, so as to compensate for the effect of the difference in the proportion of the sexes. This is theoretically true enough, but practically it may be ignored; for I find that if the proportion of the sexes in England were altered so as to be the same as ours, there would be an increase in the deaths from consumption of only 4·7 per million of population. Thus with the English population and deaths from consumption as above, the mortality would be 2·0539 per thousand. If the proportion of the sexes were the same in England as here, and the number of women the same as in 1876, the men would be 13,388,495, the male deaths 28,506, and the total deathrate from phthisis 2·0586, or an increase of only about 4·7 per million of population.

When such a fact as the above is elicited, the question naturally arises, How does sex thus modify the deathrate? Why is it that men are more liable to die of consumption than women? Why should not women die rather than men? Many answers might be suggested. But our statistics furnish us with an explanation, which I am inclined to adopt, namely, the shorter duration of the reproductive function in females than in males. The grounds upon which this theory rest will be shown a little further on in this paper.

2. Sex influences phthisis in South Australia in respect to the duration of life. The mean duration of life among men who die of consumption is 34 years and 3 months, and among women 28 years and 11 months; so that our females may be said to die about five years and a half earlier than our males.

In England in 1876 the mean duration of life was among males 34 years 8 months, and among females 31 years 1 month; from which we gather that our men die at almost exactly the same ages as they do there, but that our women do not live so long by a little over two years. This last-mentioned fact has been already shown to be more than explained by the higher average age of the living population in England, the women of England being full five years older than those of South Australia. Can we in the same way attribute the earlier deaths among the females than among the males out here to the same cause, namely, that the average female age is lower than the average male? No, not so as to furnish a full explanation; for whereas the average age of our women in 1876 was 21 years and 11 months, that of our men was only 23 years and 8 months, giving a difference of only 1 year and 9 months. But the difference in the age at death from consumption is five years and four months; therefore women are certainly attacked and destroyed at an earlier period than men. May this be accounted for by their earlier development?

## Influence of the Reproductive Power.

From consideration of our statistics we may observe that consumption is, broadly speaking, chiefly a disease of developed mature life, more strictly that it is a disease of the reproductive period of life.

If we examine a table of the absolute deaths from phthisis during the five years, among both sexes, grouped under the different ages, we find that the mortality in childhood not very great during the first year of life, sinks to its minimum between the ages of three and four. From the fourth year upward it rises through each quinquennial period to reach its maximum between 20 and 25 years, and then falls gradually and regularly to the extreme of life. If we combine these periods so as to form groups of 15 years each, there appear 97 deaths in the first, 370 in the second, 318 in the third, 147 in

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Deaths from Phthisis during the Five Years 1873-77.

| Under | Males. | Females. | Total. | Under | Males. | Fema'es. | Total. |
|---|---|---|---|---|---|---|---|
| 1 year | 12 | 8 | 20 | 35 years | 62 | 57 | 119 |
| 2 years | 7 | 4 | 11 | 40 " | 69 | 48 | 117 |
| 3 " | 3 | 1 | 4 | 45 " | 47 | 35 | 82 |
| 4 " | 0 | 1 | 1 | 50 " | 41 | 16 | 57 |
| 5 " | 5 | 4 | 9 | 55 " | 37 | 14 | 51 |
| 10 " | 7 | 6 | 13 | 60 " | 26 | 13 | 39 |
| 15 " | 11 | 28 | 39 | 65 " | 19 | 3 | 22 |
| 20 " | 45 | 75 | 120 | 70 " | 5 | 4 | 9 |
| 25 " | 59 | 69 | 128 | 75 " | 2 | 1 | 3 |
| 30 " | 60 | 62 | 122 | 80 " | 0 | 1 | 1 |

Totals—Males, 517; females, 450.

the fourth, and 34 in the fifth. It is during the second and third periods that the great bulk of people die, between the ages of 15 and 45, more than twice as many as during all the other periods put together. It seems that having escaped the trying years of infancy, as development proceeds from 4 to 5, from 5 to 10, from 10 to 15, from 15 to 20, so the deaths increase; that is to say, the nearer maturity is approached the greater does the liability become. It is between 15 and 20 years that full growth is in a large proportion of cases attained, hence we find that here the mortality almost arrives at its maximum; but not quite. It is not until from 20 to 25 that this is reached. From this period until 40 there is very little fall, the deaths remain nearly the same; but after this, during the decline of life, down to extreme years, the mortality most markedly diminishes; so that from a glance at the table of absolute deaths we might conclude that as development proceeds the deaths from phthisis increase, when full maturity is attained the deaths are most numerous, while the period of prime continues the deathrate remains almost unchanged; and when degeneration sets in and progresses then comes a decline in the deaths.

If we examine separately the statistics of the two sexes, we shall find this statement curiously confirmed; for since women develop more rapidly than men, and come to maturity sooner, we should expect to find the deaths from phthisis increasing earlier and increasing more quickly among females than among males. And such is the case. From 4 years to 5 five males die and four females; from 5 to 10 seven males and six females; that is during the period of life at which the development of both sexes is about the same, the deaths from this disease are about equal. But from 10 years to 15 only 11 males die and 28 females—between twice and three times as many; from 15 to 20, 45 males and 75 females; combining the figures from 10 to 20 years, 56 males die and 103 females, or nearly twice as many women as men. This more rapid attainment of maturity by females is quite commonly recognised, and is so markedly coincident with the rapid increase in the mortality of consumption as to present itself very prominently in the relation of cause. Nor is this a seeming coincidence from the table of the absolute mortality. It may be traced quite as markedly when we draw up a table showing the proportion which the deaths from phthisis at the various ages bear to the populations at those ages, according to the census of 1876. For instance, we see at once the great disparity between the deathrate 1·022 of 15 to 20 years for both sexes, and 0·284 of 10 to 15; and the increase of 0·284 from 10 to 15 over 0·084 of 5 to 10 years. So also we cannot but be struck with the higher rates of mortality among the females between 10 and 20 years, viz., 0·41 and 1·27 per 1,000, as compared with 0·16 and 0·77 among the males for the same period. In fact, this table confirms most strongly the proposition that consumption is chiefly a disease of maturity, and hence increases as development progresses, augments greatly on the accession of puberty, and rises almost to its maximum as soon as full physical development is attained. But it is noticeable that although from the table of absolute deaths we might have deduced the proposition that it is more a disease of the prime of life than of the degeneration period, here we should have been wrong, since this table of the relative deathrate shows that the falling off after the age of 40 is almost though not quite accounted for by the smaller population at this advanced period, and that consequently the decline of life enjoys in only an insignificant degree any exemption from this disease.

If now we consult a series of tables giving the deaths at different ages from all diseases, and the ratio which the deaths from phthisis bear to those, we find that consumption is especially a disease of maturity, and in this respect is unlike disease in general. If it were like other affections in reference to the time of life at which its attacks occur, then the ratio of its deaths to those from all complaints ought to be the same for each period of life. But it is far otherwise; for whereas between the ages of five and 10 only 16 die of consumption out of every 1,000 deaths, between 10 and 15 years 38 die, or twice as many; while between 15 and 20 years 232 out of every 1,000 deaths are due to that cause, or six times as many as are accounted for during the previous quinquennium. But the

Population of South Australia as per Census of 1876.

| Under | Males. | Females. | Total. | Under | Males. | Females. | Total. |
|---|---|---|---|---|---|---|---|
| 5 years | 15,762 | 18,852 | 34,614 | 50 years | 4,709 | 3,779 | 8,488 |
| 10 " | 15,552 | 15,232 | 30,784 | 55 " | 3,689 | 3,051 | 6,740 |
| 15 " | 13,819 | 13,696 | 27,515 | 60 " | 2,873 | 2,227 | 5,100 |
| 20 " | 11,691 | 11,784 | 23,475 | 65 " | 1,995 | 1,755 | 3,750 |
| 25 " | 9,865 | 9,183 | 19,048 | 70 " | 1,307 | 1,044 | 2,351 |
| 30 " | 8,250 | 6,980 | 15,230 | 75 " | 754 | 620 | 1,374 |
| 35 " | 7,555 | 6,320 | 13,875 | 80 " | 360 | 333 | 693 |
| 40 " | 6,537 | 5,603 | 12,140 | 85 " | 182 | 174 | 356 |
| 45 " | 5,510 | 5,101 | 10,611 | | | | |

Ratio of Annual Average Deaths per Thousand of Population.

| Under | Males. | Females. | Total. | Under | Males. | Females. | Total. |
|---|---|---|---|---|---|---|---|
| 5 years | ·34 | ·19 | ·26 | 45 years | 1·7 | 1·37 | 1·546 |
| 10 " | ·09 | ·078 | ·084 | 50 " | 1·74 | ·84 | 1·342 |
| 15 " | ·16 | ·41 | ·284 | 55 " | 2·01 | ·91 | 1·521 |
| 20 " | ·77 | 1·28 | 1·022 | 60 " | 1·81 | 1·17 | 1·528 |
| 25 " | 1·19 | 1·5 | 1·344 | 65 " | 1·90 | ·34 | 1·174 |
| 30 " | 1·45 | 1·77 | 1·602 | 70 " | ·76 | ·76 | ·764 |
| 35 " | 1·64 | 1·80 | 1·714 | 75 " | ·53 | ·32 | ·436 |
| 40 " | 2·11 | 1·71 | 1·926 | | | | |

absolute deaths are only three to four times as great between 15 and 20 years as between 10 and 15, whence we conclude that phthisis not only appears from the table of absolute mortalities as a disease of developed life; but from this table of relative mortalities its tendency to attack the fully grown is made twice as manifest.

But to speak more strictly, it is especially a disease of the reproductive period of life.

If we turn again to the table showing the absolute deaths from consumption among women, we observe that they increase rapidly from 10 to 15 years, but very rapidly indeed from 15 to 20 years, during which quinquennium they reach their maximum for all ages. From this point they gradually diminish regularly and slowly until the age of 45 is reached, when there is a sudden fall to one-half of what it was during the previous five years. For the next fifteen years the deaths vary very little, and then suddenly decrease to insignificance. That is to say, phthisis becomes eminently fatal immediately on the accession of puberty among females, so as to reach its maximum at once, remains very prevalent, though gradually

| Age in years. | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 .. .. | 2,762 | 3·26 | 2,340 | 3· | 5,102 | 3·3 |
| 2 .. .. | 533 | 11·25 | 498 | 8· | 1,031 | 10· |
| 3 .. .. | 212 | 14·0 | 194 | 0· | 406 | 7· |
| 4 .. .. | 141 | 0· | 141 | 7· | 272 | 4· |
| 5 .. .. | 230 | 22· | 191 | 21· | 421 | 21· |
| 10 .. .. | 312 | 19· | 301 | 13· | 603 | 16· |
| 15 .. .. | 198 | 35· | 192 | 130· | 390 | 38· |
| 20 .. .. | 213 | 183· | 236 | 275· | 449 | 232· |
| 25 .. .. | 265 | 185· | 254 | 232· | 519 | 208· |
| 30 .. .. | 236 | 212· | 231 | 242· | 467 | 228· |
| 35 .. .. | 287 | 185· | 246 | 203· | 533 | 192· |
| 40 .. .. | 297 | 195· | 242 | 149· | 539 | 174· |
| 45 .. .. | 302 | 119· | 216 | 143· | 518 | 129· |
| 50 .. .. | 293 | 106· | 171 | 76· | 464 | 116· |
| 55 .. .. | 317 | 95· | 161 | 81· | 478 | 90· |
| 60 .. .. | 316 | 66· | 185 | 65· | 501 | 66· |
| 65 .. .. | 281 | 60· | 176 | 11· | 457 | 42· |
| 70 .. .. | 214 | 23· | 175 | 23· | 389 | 23· |
| 75 .. .. | 206 | 5· | 154 | 6· | 360 | 5· |
| 80 .. .. | 120 | .. | 111 | .. | 228 | .. |
| 85 .. .. | 61 | .. | 52 | .. | 113 | .. |
| 90 .. .. | 23 | .. | 18 | .. | 41 | .. |
| 95 .. .. | 10 | .. | 12 | .. | 22 | .. |

A. Deaths from all diseases among males in South Australia during 1874-77.
C. " " " " females " " "
E. " " " " both sexes " " "
B. Ratio per 1,000 of deaths from phthisis to deaths from all diseases among males.
D. " " " " " " " females.
F. " " " " " " " both sexes.

less so during the continuance of the reproductive period, and as soon as the grand climacteric is passed suddenly falls to a comparatively low figure and one that remains very uniform through many years. This greater liability during the child-bearing age becomes even more evident when we group the cases. Thus, during the first 15 years of life 52 died, during the reproductive period from 15 to 45, 346; and during the next 30 years, 52. So that nearly three and a half times as many females died during the reproductive period of 30 years, as during all the rest of life put together. The reproductive age is fairly definitely limited both at its beginning and its ending in women; whereas in men the bounds are not nearly so defined. Therefore, if phthisis is specially connected with the reproductive period, we ought to find that the deaths from phthisis are in the same manner, and in the same degree more sharply confined among women to a certain age than among men. We observe now that among the males 45 die up to the 15th year, 342 between 15 and 45 years, and 130 after the 45th year, or 342 from 15 to 45, and 175 during all the rest of life; a ratio of 1·96 to 1; but among women the ratio is 3·3 to 1. Therefore, phthisis is more limited among women than among men to this age to the extent of 75 per cent. And it will be noticed, further—and this gives additional support to the theory—that the difference between the ratios does not arise during the first fifteen years of life, but is rather lessened. So it ought to be, inasmuch as reproductive powers are not commonly possessed by either sex below that age; but females are more likely to possess them, more often possess them, than males. On the other hand, we perceive that the difference between the ratios does arise during the years after 45, owing to a greater number of deaths among the men than among the women; whereas among women, in whom this power so suddenly ceases, the fall is sudden after 45 years. Among men it does not suddenly fall, but continues much more gradually to decline down to 60 or 70 years of age, until which period this function is known still to persist. So that from the table of absolute deaths we may say that phthisis is very markedly a disease of the reproductive period of life. Moreover, we must modify somewhat our first proposition, viz., that it is especially a disease of maturity, inasmuch as the reproductive function rather than maturity seems to govern the fatality. We may much more accurately affirm that the reproductive function is that which especially rules our statistics of consumption. When this begins to be possessed, then phthisis begins to be much more prevalent. Since it is established earlier among women, consumption occurs at an earlier age among them; since it is suddenly lost by females, consumption suddenly becomes less common amongst them; since it is retained by men down to the extremes of life, consumption loses little, if any, of its virulence among elderly males.

To ask the question whether this is special to phthisis, or common to disease in general seems absurd, for we find that during four years 3,857 females died from all diseases below the age of 15, 1,425 from this period up to 45 years, and 1,215 beyond this age; or 1,425 during the reproductive period, and 5,072 at all other ages, a ratio of 1 to $3\frac{1}{2}$ instead of $3\frac{1}{2}$ to 1.

But we may still inquire whether the table giving the percentage of deaths to the population confirms the proposition deduced from the table of absolute deaths. Without entering into all the particulars, we may say that it is confirmed in every point. The deathrate among the females per thousand of living population from 10 to 15 is ·41, from 15 to 20 it is 1·27, more than three times as great. This is the sudden rise on the accession of puberty in the female. From 40 to 45 it is 1·37; from 45 to 50 it is ·84, a considerable fall at the cessation of the reproductive function. The rate from 15 to 45 is 7·7, for all other ages only 1·4, or 4·5 times as great. The rate from 45 to 75 is 4·2, or only a little more than half that of the reproductive period. Among the males the rate from 10 to 15 years is ·16, only a slight increase over that of ·09 from 5 to 10, when compared with that among females, viz., from ·079 to ·41, explained by the existence of puberty among girls under 15 much more frequently than among boys. From 15 to 20 years it is ·77, a great advance over the rate of ·16 from 10 to 15, concurrent with the setting in of puberty among the great majority of males. From 15 to 45 years it is 6·9, at all other ages 2·9, or only 2·4 to 1, instead of 4·5 to 1 among the females, corresponding with the absence of any limitation of procreation among men. From 45 to 75 the rate is 8·5 per thousand, an increase over that from 15 to 45, and very different from the 4·2 per thousand among the females, which is a decrease from that of 15 to 45 amongst them, and presenting very boldly the different liability to phthisis among men and women after 45 years, where the difference in regard to the reproductive function is so manifest.

To test this theory, if possible, still further we may consider males as almost certainly in possession of the reproductive function from the age of 20 down to the extremes of life. There were in the year 1876 53,044 men of this age, and among them there were 427 deaths from consumption. Women we may almost as certainly regard as procreative between 15 and 45, of which age there were 44,971 persons in 1876, with 362 deaths in the five years. Here, then, we have the two classes of such ages, that both are under the action of the one cause, and so far as we can judge about equally. How do the ratios compare?—427 is to 362 as 53,044 is to 44,965, which 44,965 is so close an approximation to 44,971 as to be quite remarkable. So that it is evident that when men and women are of the reproductive age, and therefore are both under the influence of this predisposing cause, they are both to an exactly equal degree liable to consumption. Beyond the age of 45 there were 15,327 men with 130 deaths, and 12,376 women with 51 deaths; but with this number of females there ought to be 105 deaths, if the rate were the same in the two sexes. So that among the women after 45 it is only one-half what it is among men. Since after 45 the mortality among women is but little more than one-half that before 45, it might be laid down as a rule in female insurance that a consumptive history should only be estimated at one-half the importance after 45 that it holds prior to this age. It would seem, then, that so long as women are subject to this predisposing cause they are as liable to consumption as men, but that directly this influence is withdrawn they are only half as liable. This to my mind appears almost like a demonstration of the theory that the reproductive function is a great predisposing cause of phthisis. Would it be presumption to assert that this cause accounts for one-half of the phthisis mortality. If we compare phthisis among the two sexes—up to 20 among males, and up to 15 among females—it would seem at first glance as though the deathrates should be equal, because above we have reckoned from these ages. On examination, however, we find them not equal. There are 56,824 males and 47,780 females; 90 deaths among the former and 52 among the latter. But to be in the same proportion the female deaths should be 76; therefore it would seem that even when the influence above indicated is absent from both sexes the deaths from phthisis are among males half as much again as among females. This would seem to oppose the theory. But the opposition is only seeming, for although in our former calculation we started from the ages of 20 and 15, this was not because all below those ages are free from the influence, but because practically all above those ages are subject to it, for without doubt many are possessed of this function at earlier years, and it is quite certain that this is the case to a much greater extent among males below 20 than among females below 15. Hence it is not proper to compare the sexes below those ages respectively. We should expect the rate to be higher among the males. That it is higher rather supports than opposes the theory.

On the other hand, it will be as useless and improper to contrast the sexes, both up to 15 years, because it is fairly certain that the function is far more likely to exist among females than males, and so the deathrate would rule higher among them. Hence we find that there are 45,733 boys with 45 deaths, and 47,780 girls with 52 deaths; so that the mortality is greater among the girls. And if we limit the examination to the sexes under 10 we have to deal with such an insignificant number of cases and so large a number of children comparatively that any result would decide nothing at all.

In this influence of the reproductive function we find, I believe, an answer to the question, Why is it that males are more liable to the affection than females? Why do 16 men die to every 15 women? Because phthisis is ruled by reproductivity, and this is more persistent among men than among women, and so acts upon them for a much longer period.

If this theory be correct it opens up a very wide field for speculation as to whether it may not be through this channel that many supposed causes act. Is it true, as is popularly supposed, that phthisical females are more prolific than others? If it be, may we not read the fact reversely, that prolific women—women in whom the reproductive power is very strong—are more liable to phthisis? The influence of city life, sedentary employments, indolence, on the one hand; a country life, open air exercise, and muscular pursuits, &c., on the other, may exert their predisposing or antagonising influences through this medium. But we will cease even to suggest, lest we should appear to be riding the theory too far.

Such, then, seems to be some of the information to be derived from our colonial statistics respecting this generally interesting disease; of so general interest because there are few if any families that have not been invaded by it. None the less interesting, both to the faculty and the laity, in that the information derived is not altogether in accord with popular notions upon the subject. There are some points for congratulation. Our deathrate is not one half of that in the old country, and probably the disease does not attack us so early, nor run so rapid a course. We may remember, too, while we "groan and sweat under our weary life" in summer, that there is at least one class of patients to whom this season comes with comfort and prolongation of days. But we ought to remember especially—and this is cause for solicitude rather than congratulation—that the mortality is increasing, and it behoves us in the interests of medical science—and none the less in the interest of our fellows—to find out the reason why: whether because the beneficial influences of our climate are becoming more widely known, and attracting more sufferers, who, as a forlorn hope, come to our colony to die, or whether because of deleterious circumstances, which we are creating and fostering, but which we ought to be lessening or stamping out. The first step to this end seems to be to ascertain the duration of residence in the colony of every victim of this disease. This could easily be effected by the medical men, and being entered henceforward on the certificate in the allotted space, would allow for a return for the last half-year of 1879, and by the end of 1880 we should have data for a fairly correct determination of the question raised.

# THE INSECTS OF SOUTH AUSTRALIA: AN ATTEMPT AT A CENSUS.

By OTTO TEPPER, Corresponding Member.

Scientific knowledge concerning the Entomology of South Australia appears to be in a considerably less satisfactory state than in the other Australian provinces, to judge by the researches of the President of this Society contained in the Anniversary Address, and published in the "Transactions, &c., of 1878." There is little or no scope to doubt that the facts are as stated. Whatever the causes may be, there is certainly a wide field open for individual and collective effort ere the province will compare favorably in this respect with its neighbours. They have splendid handbooks of their living and extinct fauna and flora, well illustrated, and published at a price within reach of all; splendid public collections of specimens properly arranged and named; and information can be obtained on any subject at a nominal fee—all through governmental foresight. With us little of the kind is found, and (sad experience compels me to say it) the most zealous amateur, if not possessed of great connections and ample means, soon ceases in his efforts, when he finds it next to impossible to obtain the true name of any but the commonest natural object; for, without a name there is no real knowledge. How does he know when he discovers anything *new?* To aid progress he must be able to advance by study to the very confines of what is already known; and this he can only accomplish by means of proper public institutions, else he wastes his energies upon work done over and over by others. The following short review of South Australian insects contained in my private collection is intended only as a small contribution towards elucidating the subject.

The enumeration of the genera and species is interspersed with remarks about the habits, &c., of the most remarkable ones, in order to make the subject less monotonous.

For more than twenty years some of my scanty leisure hours have been devoted, among other kindred pursuits, to the observation and collection of insects in various localities within the southern portion of this province, the outer limits being Mount

Bryan in the north and Mount Gambier in the south. Through various causes the earlier collections were lost to me, but not the experience gained. The present collection to be reviewed in the sequel dates in its beginning about twelve years back, was brought together within a very limited area, and comprises, in round numbers, about 2,600 species (while in the anniversary address cited above the author only enumerates 782 species as scientifically known to exist in *all* South Australia !), gathered within a radius of a few miles around New Mecklenburg, Lyndoch, Tanunda, Nuriootpa (N.), Callington, Monarto (E.), and Ardrossan, Y.P. (W.) Having always kept specimens from other parts of Australia, &c., *strictly* separate, the numbers given can be confidently taken as referring to really indigenous insects. The three principal centres from which my excursions radiated were—(1) New Mecklenburg, four miles W. of Tanunda, and includes Lyndoch; (2) Nuriootpa, four miles N. of Tanunda; (3) Monarto, eight miles east of Callington, including the neighbourhood of the latter and the scrub to the Murray River, and comprising by far the largest area.

These three specialised areas, furnishing quite 95 per cent. of the insects to be mentioned, overlapped each other very little; the remaining five per cent. were got by occasional short visits to other localities, and friendly exchanges in slight proportion. At the first place named 587 species were obtained in four years; at the second, 785 additional in nearly five years; and at ths last, 948 additional, in eighteen months. But it is not to be understood that so many species are strictly peculiar to each locality, but only that they were there obtained first. The following table shows in a condensed form some details of the distribution of the respective orders, but one—the Aptera—has not had attention paid to it:—

Table of the Numbers of Families, Genera, and Species of South Australian Insects.

| Orders. | Number of Families. | Number of Genera. | Number of Species. |
|---|---|---|---|
| 1. Coleoptera .. .. .. .. | 18 | 198 | 1,411 |
| 2. Lepidoptera .. .. .. .. | 19 | 80 | 395 |
| 3. Hymenoptera .. .. .. | 14 | 34 | 240 |
| 4. Orthoptera .. .. .. .. | 7 | 16 | 134 |
| 5. Hemiptera .. .. .. .. | 12 | 28 | 272 |
| 6. Neuroptera .. .. .. .. | 9 | 16 | 43 |
| 7. Diptera .. .. .. .. | 8 | 17 | 159 |
| 8. Thysanura .. .. .. .. | 1 | 1 | 1 |
| Total .. .. .. .. | 88 | 390 | 2,655 |

## ORDER COLEOPTERA.

The COLEOPTERA, or beetles, form the most numerous order of Insecta, 80,000 species being mentioned by Dr. Leunis (Naturgeschichte, 1868) as known to exist, and are represented in my collection by more than 1,400 species, constituting 53 per cent. of the whole, yet by no means comprising nearly all the species known to exist in the localities indicated. In the arrangement Latreille's system has been principally followed on account of its simplicity.

Commencing with the CICINDELÆ: their rarity is very remarkable, only five species in two or three genera having been obtained. One species of the typical *Cicindela* occurs near Lake Alexandrina, white and dark-grey in colour, where it is fairly numerous at times. Another, very rare and minute, was taken at New Mecklenburg, near the banks of the Gawler. A brilliant golden green *Tetracha*, *said* to have been taken near Port Wakefield, occurs in the Far North, and also near the Australian Bight, as I have been informed. A small, dark-coloured species, glittering as if bedewed by jewels, related to *Tetracha*, was taken near Nuriootpa and at Ardrossan.

The CARABIDÆ are more numerous than the foregoing, mustering 123 species in about 28 or 30 genera. Some of the latter are fairly rich in species; thus *Bembidium* is represented by ten, *Carabini* (all small) by fourteen, *Chlænius* by eight, *Scaritidæ* by thirteen (the largest about one and a quarter inch

TABLE SHOWING NUMBER OF GENERA AND SPECIES OF THE FAMILIES AND GROUPS OF COLEOPTERA.

| Families and Groups. | Number of Genera. | Number of Species. |
|---|---|---|
| 1. Cicindelæ .. .. .. .. .. | 2 — 3 | 5 |
| 2. Carabidæ .. .. .. .. .. | 28 — 30 | 123 |
| 3. Natatores .. .. .. .. .. | 4 | 21 |
| 4. Staphilini .. .. .. .. .. | 5 — 6 | 26 |
| 5. Mordellæ .. .. .. .. .. | 3 | 21 |
| 6. Elateridæ .. .. .. .. .. | 6 — 7 | 42 |
| 7. Buprestidæ .. .. .. .. .. | 9 — 10 | 143 |
| 8. Rhipiceræ .. .. .. .. .. | 1 | 2 |
| 9. Clerici .. .. .. .. .. .. | 10 | 37 |
| 10. Lamellicornia .. .. .. .. .. | 28 — 29 | 144 |
| 11. Clavicornia (Imhoff) .. .. .. .. | 13 — 14 | 89 |
| 12. Baculicornia .. .. .. .. .. | 2 | 6 |
| 13. Heteromera .. .. .. .. .. | 15 — 16 | 113 |
| 14. Meloidæ .. .. .. .. .. | 4 — 5 | 27 |
| 15. Chrysomelidæ .. .. .. .. .. | 7 — 8 | 123 |
| 16. Ciclicæ .. .. .. .. .. .. | 2 | 82 |
| 17. Rhynchophora .. .. .. .. | 20 | 289 |
| 18. Longicornia .. .. .. .. .. | 25 — 26 | 118 |
| Total .. .. .. .. .. | 186 — 196 | 1,411 |

in length, viz., *Scaraphites crenaticollis*—Mount Gambier, Bremer, Glenelg; and *Sc. donastes*—New Mecklenburg, Ardrossan), *Calixia* by fifteen, *Philophlaus* by twelve, *Adelotobus* by six, *Sylphomorpha* by five, *Pterostichus* by four species. Other genera again exhibit but one or two representatives, as *Catadromus* (*C. australis*, the largest beetle of the family, attains the size of one and three-quarter inches at Blanchetown, River Murray; while those captured at Lyndoch and Blumberg are much smaller, and may be, though coloured similarly, a distinct species). Other genera, similarly poor in species, are *Calosoma* (two), *Platysoma*, *Hellus*, and *Brachinus* (each one). The last is the curious Bombardier Beetle, emitting a small puff of blue smoke several times in succession, with a perceptible noise when approached by the hand. They were taken near Lyndoch and Nuriootpa. In February last I met for the first time, and in a single instance, with a species of *Eudema* at Ardrossan, resembling a species from Queensland. Some other genera, names unknown to me, make up the total given above.

Of Natatores, the Water Beetles, twenty-one species (not including the largest of all, the gigantic *Hydrophilus* of Lake Alexandrina) have been obtained, forming at least four genera, viz., *Dytiscus*, four; *Gyrinus*, two; *Hydrophilus*, seven; and *Hydrocanthara*, eight species. The giant of the family measures about two inches; the smallest scarcely exceeds one-twelfth of an inch in length.

The Staphylini, those curious beetles with shortened elytra, are, except two or three species, generally very rare, showing a total of twenty-six species in five or six genera.

Proceeding to the Serricornia, those Coleoptera which exhibit more or less serrated or saw-like antennæ, we find them in plenty. They will be enumerated under five heads.

The Mordellidæ, a family of small-sized beetles, living upon the sweet juices of flowers, and whose last pair of legs is fitted for leaping, furnish us with twenty-one species in two or three genera. Some of the species are exceedingly numerous in their season, every flowering Eucalypt or Melaleuca hiding numbers of them.

The Elateridæ are much more numerous in species than the preceding, supplying a contingent of forty-two in, probably, six or seven genera. All, with exception of one or two, are of sombre uniform colour, ranging from light brown to jet black. One species, not enumerated (because not in the collection), is known by me to occur in the Barossa Ranges. It is of small size, but great beauty, the thorax of a bright red and the elytra of metallic steel blue colour. The largest *Elater*, inhabiting the Gawler scrub, is about one and three-quarter inches long and three-eighths of an inch wide; the next in size, less in length but the same width, was obtained near Callington; and a third, about one inch, at Ardrossan. All three of a dull black hue. In one instance only a single *Eucnemis* was taken (near Nuriootpa), a genus distinct from *Elater*, by the absence of the power to project itself forcibly upwards, when placed upon the back, and the more cylindrical shape of the body.

The BUPRESTIDÆ which are the pets of most entomologists, on account of their varied brilliant coloration, are represented by 143 species in at least ten genera, and form one of the most numerous families. The genus most prolific in species is *Stigmodera* with 71. Among the *Buprestids* are some of the largest South Australian Coleoptera, viz., two *Stigmodera* and one *Sternocera*, species attaining or approaching the respectable length of two inches and a width of three-quarters of an inch. Two species are peculiar to the pines *(Frenela robusta)*, three or four to *Casuarina stricta* (sheoak), a large number to the Acacias *(A. pycnantha* and others), and one or two—viz., *Cyria imperialis* and another, live upon *Banksia marginata* (honeysuckle), but by far the largest number have their wants of life supplied by the flowers, &c., of *Eucalyptus*, *Leptospermum*, *Melaleuca*, and *Callistemon*. The larvæ of most live (for years it seems) in the living wood and bark of the trees, apparently eating their way downward, as the beetle generally makes its appearance through an opening near the roots. Some larvæ live in the adhering, dead, corky bark of *Eucalyptus rostrata* and other trees, and the beetles of these are in many instances distinguished by metallic colours. Only one or two live upon grasses, and are very minute.

RHIPICERA is only represented by two species, of which one hails from Mount Gambier and the other was obtained at Monarto. The latter is possibly only a variety.

The CLERICI show a tolerable variety of forms, presenting 35 species in about ten genera. *Natalis*, including the largest in size, and *Trichodes* are the most conspicuous. They are widely different in their habits, some being carnivorous, others licking the nectar of flowers. The larvæ of some live under the bark of trees; that of one species inhabits a large spongy fungus growing parasitically on the branches of large Eucalypts, and another finds the *ne plus ultra* of existence in putrid carcases of animals, which the perfect beetle also frequents.

The LAMELLICORNIA, or Coleoptera with leaf-like extremities to their antennæ, are well represented by at least 29 genera with 144 species. The most numerous family is *Melolontha*, comprising, with its near allies, 69 species, some of which attain a considerable size (exceeding one inch), but most are small. All are destructive to vegetation—one species, pre-eminently so at times, I described in a paper published in the "Transactions of the Adelaide Philosophical Society, 1878," and named it provisionally "*Melolontha destructor.*" Some smaller species are occasionally as destructive in proportion to their size upon small bushes, but are seldom noticed The *Rutelidæ* are represented by two genera—*Anoplognathus* (one species) and *Repsimus* (three species, perhaps only local varieties). All are large beetles, and the individuals of the former frequently swarm in hundreds during warm evenings in spring, buzzing among the leafy tops of *Eucalyptus rostrata* and *E. viminalis.* Their browsing in zigzag lines betrays them unerringly to the observer, as no other South Australian beetle seems to indulge in this singular habit. *Scarabæus,* and four or five allied genera, furnish 19 species, most of medium size, some attaining one inch in length. *Gryphodes* musters 7 species; *Trichius* 1; *Copris, Geotrupes,* and the rare *Bolboceras* 19 collectively. The commonest of the *Copridæ,* also the largest, infests the droppings of cattle, &c., in numbers, and drills deep circular holes in the hardest soil underneath for the accommodation of its eggs and larvæ, for which purpose it is fitted with a large horn upon the head and four on the prothorax. Its colour is a dark, glossy chestnut. The family of the beautifully-formed *Cetonias* contains three genera, of which *Schizorrhina* is the most numerous, containing 8 species, the other two being represented by one each only. The largest of the *Schizorrhina,* said to be from Mount Remarkable, measures one and a half inches. The smallest *Cetonia* of another genus exceed half inch scarcely, and was noticed at Callington, but is numerous at Ardrossan. One of the *Schizorrhinas,* jet black, with green spots upon the upper and bright yellow markings on its legs and abdomen, lives upon *Eucalyptus viminalis,* the larvæ inhabiting the decaying inner portion of the same trees, and when entering into the chrysalis state form oval, cocoon-like cases for themselves by glueing together their own hard, roundish excrements and grains of soil. *Passalus* seems unrepresented in our neighbourhood, but Mount Gambier furnishes one large species, similar, if not identical, to a Victorian ally, and one and a half inches long. *Figulus* contains five closely allied species, all of which (and larvæ as well as imago) inhabit dead decaying wood. Of the magnificently-coloured *Lamprimus* two species are represented. Both are similarly coloured—the males of a brilliant metallic golden hue, the females of a lustrous golden green; but in the one species, which feeds upon the large native marshmallows, the male exceeds the female much in size, while in the other, feeding upon gum-leaves, this is not the case, or only slightly. Besides these, I obtained once some specimens of a species (in the Barossa Ranges) having the prothorax very conspicuously marked with indentations. Another species observed at Mount Gambier is distinguished externally by both sexes being of the same colour—a golden leek-green—and nearly of the same size. The *Trogidæ* are not very numerous, showing about three genera with nine species, the majority living in putrid matter, one in very moist manure.

The Clavicornia, or club-horned beetles, are rich in forms, but fortunately less so in individuals, for most are extremely destructive to animal substances, comprising about 13 or 14 genera and 89 species. *Histeridæ* are catalogued with 13, *Hololepa* with 2, *Nitidula* with 3, *Sylphæ (Hemaphila)* with 1 species. The last is of large size, above an inch; but, frequenting putrid carcases, manure heaps, &c., upon which it and its larvæ feed, possesses, though looking pretty, a perfectly horrid odour. *Conetelus* and its allies number 17; *Coccinella* 2 species. The *Dermestidæ (Anthrenus*, &c., incl.) are at least in one species very numerous in individuals; 21 species are in the collection, and another was observed in a solitary spot near Lyndoch, within the charred hollow of a large *Eucalyptus rostrata*; it is jet black and covered with numerous white dots; length one quarter of an inch, width less than one-twelfth inch. *Paussidæ* are very rare; three species were captured. *Cephalotes* (?) are numerous in individuals; 11 species (some doubtful) have been obtained. The *Ptinidæ* and *Anobii* are also mentioned here on account of their similarity of habit, and are not very promiscuous in number. *Gibbium* appears in six and one or two other genera in seven species.

The Baculicornia (Dr. Imhoff) appear to form about the smallest group of beetles, *Collydium* comprising four, and *Brentus* one, perhaps two species. The latter I found rather numerous on ferns at Mount Gambier (which covers there extensive parts of the country), but much less so at other places, and generally under lose bark.

The Heteromera present a great variety of forms in about fifteen or sixteen genera, with 113 species, among which *Tenebrio* numbers six, *Tentyria* two, *Akis* six, *Blaps* four, *Opatrum* eight species; these latter are found generally under loosely-adhering bark, where they and their larvæ feed upon decaying substances, and are all of a dusky hue, but while alive are covered with fine white dust, easily removed by a touch, lending them a purplish tinge. *Saragus* adds eight, *Helops* five (one of these, one inch in length, jet black, while in the larval state, mines through and feeds upon the decayed outer portion of very old dry gum-trees), *Adelium* eighteen species. Some of the last could once be taken in scores at certain spots in the Barossa Ranges, where a few years later very few could be found. They possess in common with the two following genera a curious weapon of defence in one or two hand-like processes, which they protrude from their anal extremity, moistened with some adhesive fluid of disagreeable odour. *Titæna* comprises ten species, some of which are among the first beetles appearing in spring. The majority of the ten species of *Amarygmus* are endowed with most beautiful iridiscent colours when alive, owing to the extremely fine crenulation of their upper parts. The largest and most beautiful species lives upon mallee *(Eucalyptus dumosa)* and is three-quarters of an inch in length; the smallest scarcely a quarter of an inch. There is only one species of *Lagria* found in the neighbourhood of the large common fern, and one *Bictomis* under the bark. Of *Helæus* and its near allies there are seven species indigenous (three more besides were taken at Ardrossan), *H. princeps*, Hope, the largest and commonest, occurring at New Mecklenburg, Monarto, and Ardrossan. *Lyctus* (with perhaps one or two other genera included) with seven, and *Bostrichus* with two or three species, conclude the list.

The family of the MELOIDÆ is sparingly represented. Of the genus *Meloe* I only know one species, living upon a small shrub in the hills about Williamstown and the South Para, but is not in the collection. The *Lyttae* in three or four allied genera muster twenty-seven species in all. In former years some species were fairly numerous, but of late I find them all rare, or even very rare. Some are arrayed in brilliant colours, in one the male entirely different from the female.

The CHRYSOMELIDÆ are rich in species, but all small, none exceeding one quarter of an inch. Their seven or eight genera contain a total of 123 species. *Chryptocephalus* comprises twenty-six, *Haltica* nine, *Eumolpus* fourteen, *Podontia*, with its near relations, thirty-two, *Chlamys* twenty-one, and the *Cassidæ* twenty-six species.

The CICLICÆ are very numerous, are partly plant-feeders, partly carnivorous; some fly by day, others by night. The genus *Paropsis* is the most numerous, furnishing with an ally seventy-six species, some of which, while alive, exhibit brilliant red, green, and blue colours, fading into a dull uniform yellow a few hours after death; other species change their delicate neutral tints into a bright brick red, within a few days. Among the fifteen species of *Polyglypha* is one nearly approaching in colouration the notorious Colorado Beetle, but it is rather rare and seemingly harmless. Another species is clothed in resplendent golden green, iridising in all colours of the rainbow. It is small in size, but found at times in considerable numbers upon certain shrubs from Mount Bryan to Callington, from the Murray to Ardrossan.

The RHYNCHOPHORA, or weevil-like Coleoptera, are the most numerous family here as elsewhere, furnishing at least 20 genera, with 289 species. The *Bruchidæ* and their relatives number 22 species, some over an inch in length and some under a quarter of an inch; some of very strange appearance, caused by curious excrescences upon prothorax and elytra; all are wingless, mostly living on or under the ground; their elytra are firmly joined in one piece of armour. The *Curculionidæ* present 21, the *Anthonomidæ* 30 species, some of which are active all the year. *Rhynchaena*, with *Gonipterus*, count 29 species, one of the latter in almost endless variety; *Apoderus* 20, *Anthribus* 15, the *Apionidæ* with over 20, *Cossonus* 8, the largest infecting *Eucalyptus rostrata*, *Rhinomacer* 5, all rare; *Eurhynchus* 3, *Hypphorynus* 4, including the giant, and also the most beautiful (the black and golden green Diamond Weevil) of the whole family; *Balanius*, with its kindred, 38; *Rhinotia* 15, and *Belus* 26 species. Both the latter genera are peculiar to Australia. *Lixus* occurs in one species, said to have been obtained near Angaston.

The LONGICORNIA, the long-horned or Wood Beetles, are well represented by 118 species in about 26 genera, but many are very rare. The first in array are the *Prionidæ*, with five well-defined species; the larvæ of the largest feeds within the trunks of the *Casuarinæ*, the beetle attaining the length of nearly three inches; another species peculiar to *Eucalyptus viminalis* and *rostrata*, measures 2¼ inches. The large oval holes seen in timber are due to their larvæ, the circular ones being drilled by the larvæ of moths. Both kinds of larvæ are eaten by the natives. The *Cerambidæ* (*Mallodon*, *Epithora*, &c.) number 18 species, the largest exceeding 1½ inch in length. *Pyrocantha* contains 18 species, the commonest, *P. recurva*, is found sometimes swarming in hundreds after sunset around felled gumtrees, or broken branches, in the bark of which their eggs are deposited, the larvæ, when hatched, feed first upon the bark and afterwards enter the splinth. This species extends to the Northern Territory. *Molorchus* contains one species, noticed at Lyndoch and Monarto. Of *Clytus* (or a closely allied form) there are three species; of *Phacodes*, *Callidypsis*, and another one each; *Chlythanthus* and *Leptura* two each; *Stenodema* numbers ten; *Stenoptera* four; *Hesthesis* three species. Both the latter genera have their elytra very much reduced in length, simulating wasps in appearance. One species of *Hesthesis* seems identical with *H. plorata*, from Tasmania, the other is much larger. One species of *Eurispa*, one resembling *Ctenodes*, two genera, the larvæ of one of which appear to feed upon the roots of tufted grasses, and the appearance of which signalizes the approaching end of the insect season, and another with soft elytra, feeding on Eucalypts (both with two species) add a total of six to the number.

The *Saperdæ* are numerous, *Lamida* exhibiting fourteen; *Symphyletes* twelve; *Hebescesis*, seven; *Distema*, two species.

Besides the above, a *Mallodon* specimen was in one instance taken by me near Lyndoch, just having made its escape from its larval abode in a large *Eucalyptus rostrata*, resembling (if not identical) in colour and size a species from the Northern Territory, one and a half inches in length. A species of *Distichoceras*, resembling *D. maculicollis*, from New South Wales, was once captured by me near Williamstown, by the Victoria Creek, but not seen since.

The largest of the South Australian *Lamidæ* noticed by me was taken by a friend near Callington; it exceeds one and a quarter inches in length.

After a somewhat hasty comparison of the beetles captured at Ardrossan with those collected elsewhere, it is found that altogether 266 species of Coleopters were taken, of which 106 are common to other places, while 158, or 62 per cent. of the whole number, were obtained here for the first time. Two of these Coleopters deserve a short notice. The one is allied to the Prionidæ, and seems to form a link between them and the Buprestidæ, for the form of its body closely resembles theirs; while the antennæ, mandibles, &c., denote their other connection. Their colour is a bright-brown, and their length nearly one inch. The other remarkable beetle belongs to the Dorcadiæ, and to a genus not before represented in the collection, and closely resembles some species of Bruchidæ, indigenous here, were it not for its antennæ, &c. Both species seem very rare. The first was taken in January, the other in February last.

The generic names given above have been taken partly from the following works, viz., Dr. Imhoff's "Studium der Coleopteren," 1856; Brockhaus' "Text zum Bilder Atlas," 1857; Dr. Leunis' "Naturgeschichte," 1869; Dr. Ruete's "Zoologie," 1843. Some names were obtained through exchanges with other collectors, notably to Messrs. J. French, Melbourne, and E. D. Atkinson, Tasmania, my thanks are due. Only a very few names were got from the South Australian Museum.

## Order Lepidoptera.

The Lepidoptera of South Australia are characterised by almost total absence of gay and brilliant hues, especially among the nocturnal tribes; the overwhelming majority only presents inconspicuous neutral tints. The cause of this may be sought for chiefly in the great dryness of the atmosphere, and the obvious protection it affords in seasons of drought in concealing them from birds and other enemies in eager pursuit of anything capable of serving as food.

The PAPILIONIDÆ, or butterflies, furnish 26 species in twelve genera, according to the determinations of the Hon. W. MacLeay, Sydney, of a series of figures drawn by me and submitted to him by the President, to both of which gentlemen my thanks and acknowledgment are due. There is one *Papilio* (*P. Erythonius*), the largest of the family, and measuring three and three-quarter inches in span. It inhabits the open glades in the Barossa Ranges. The *Pieridæ* are represented by *Pieris Aganippe*, Don., and *P. Teutonia*, Fabr., flying in the neighbourhood of Lyndoch, Nuriootpa, Monarto, and Ardrossan. *Terias smilax*, Don., sometimes is numerous near Lyndoch, and occurs at Ardrossan. Of *Nymphalidæ*, the genera *Pyrameis*, with two species, viz., *P. cardui*, Linn., and *P. itea*, Fabr., and *Junonisa* occur; the latter only represented by *J. velleda*, Linn. The first and last are very common, and fly nearly all the year; *P. itea* is rare. The *Satyridæ* likewise

TABLE SHOWING FAMILIES AND NUMBER OF GENERA and SPECIES OF LEPIDOPTERA.

| Families. | No. of Genera. | No. of Species. |
|---|---|---|
| 1. Papilionidæ .. .. .. | 12 | 26 |
| 2. Crepuscularia .. .. .. | 5 or 6 | 10 |
| 3. Noctua-Lithosidæ .. .. | 1 | 3 |
| 4. Arctiidæ .. .. .. .. | 4 | 4 |
| 5. Liparidæ .. .. .. .. | 3 | 8 |
| 6. Cossidæ .. .. .. .. | 2 | 9 |
| 7. Cocliopodæ .. .. .. | 2 | 4 |
| 8. Hepialidæ .. .. .. | 1 | 4 |
| 9. Psychidæ .. .. .. | 2 | 12 |
| 10. Saturnidæ .. .. .. | 3 | 3 |
| 11. Bombicidæ .. .. .. | 2 | 10 |
| 12. Notodontidæ .. .. .. | 1 | 4 |
| 13. Cymatophoridæ .. .. .. | 1 | 4 |
| 14. Noctuidæ .. .. .. | 13 | 52 |
| 15. Chlœophoridæ .. .. .. | 2 | 4 |
| 16. Agaristidæ .. .. .. | 2 | 4 |
| 17. Geometræ .. .. .. | 10 | 78 |
| 18. Tortricidæ .. .. .. | 2- 3 | 39 |
| 19. Tinea, Pyralis, Alucita .. .. | 9–10 | 117 |
| Total .. .. .. .. | 77-80 | 395 |

furnish two genera, but with only one species each, viz., *Xenico Klugii*, Gner., which is common almost everywhere; and *Heteronympha Merope*, one of the largest and finest of our butterflies, but rather rare. It has been captured at Lyndoch, and seen at Ardrossan. The occurrence of *Danais Chrysippus* is very curious, it being at home also in the Grecian Isles and on the Mediterranean shores, according to Dr. Berge. My specimen was caught in Nuriootpa. Of *Lycænidæ* several genera are represented, viz., *Lycæna discifer*, Fabr.; *Cupido bretica*, McLeay, *C. agricola*, and six others; the largest of which measures one and a half inches, and the smallest only three-quarters of an inch in span. The largest of the family is *Ogyris otanes*, Feld., occuring in the sandhills near Nuriootpa, which is the only locality I have noticed it. The female has a short, broad cross band of light yellow upon the anterior wings, of which the male is deficient. The *Hesperidæ* furnish one genus, viz., *Hesperilla*, with two species, both probably new, and rare at the best of times. Of the *Uranidæ* we have four species of one genus, viz., *Synemon læta*, MacLeay, *S. scaria*, Feld., and two others, probably unnamed. The genus is the only one, it appears, peculiar to Australia, and is not referred to in G. Master's "Catalogue of Diur. Lepid., 1873;" but it is placed here among the butterflies, because the antennæ terminate with a true club, and they often carry their wings upright like all true day-flyers, while the other genera included in the group do not do so.

The Crepuscularia, or dawn moths, are still more conspicuous by paucity of representatives than the foregoing, and mostly very rare. Of *Sphinx* there are only two species known to me, both of medium size, viz., two and a quarter inches in span; one *Macroglossa* bred from a chrysalis found at Nuriootpa, a species resembling *Thyria;* one *Zygæna* from Monarto, and five of *Sesia*, or near allies; thus only showing ten species in five or six genera.

The Noctuadæ, or moths proper, furnish the great bulk of species, there being no less than 125 *Nocturnæ*, 78 *Geometræ*, 39 *Tortricidæ*, 106 *Tineidæ*, six *Pyralidæ*, and five *Alucitæ*, and their allies. The work of reference chiefly followed is almost exclusively Berge's "Schmetterlings Buch," but the four last tribes are not treated, and therefore only mentioned collectively in the sequel. Of the 24 families of nocturnal Lepidopters therein described several seem to be entirely absent, notably the *Syntomidæ*, *Heterogynidæ*, &c., and others are only sparingly represented.

Of Lithosia three species occur. The Arctiidæ are represented by the genera *Deiopeia*, *Emydia*, *Euprepia*, and *Spilosoma.*

The LIPARIDÆ furnish three genera and eight species, viz., *Leucoma*, three; *Ocneria*, one (obtained from chrysalides at Ardrossan); *Porthesia*, four.

The COSSIDÆ supply the largest moths in the Province, one species of *Cossus*, Fabr., exceeds seven inches in span, and two or three others approach it in size. The larvæ of these inhabit the trunks and main branches of divers Eucalypts, drilling circular holes about three-quarters of an inch in diameter through the sound timber. Eight species are in the collection.

Of the allied *Zeuzera*, Latr., one specimen was taken at Ardrossan.

The family of the COCLIOPODÆ, of which the caterpillar forms hard, egg-shaped cases for the chrysalis, the latter developing its limbs in distinct and separated casings, the genus *Limatodes*, Latr., exhibits one, and *Promecoderis* three species. The HEPIALIDÆ furnish four species in one genus. PSYCHIDÆ are numerous; the genus *Psyche*, Schr., containing five, and *Oreopsyche*, Sp., seven species. The caterpillars of this family form for themselves a dwelling, consisting of a silky bag overlaid with little sticks, &c., in which also the chyrsalis state is passed. Woods mentions the largest of these bag-bearers under the generic name *Oiketicus*, I believe. The SATURNIDÆ seem scarce, only three species having been found, representing as many genera, viz., *Endromis*, Ochs.; *Saturnia*, Schr.; and *Attacus*. The latter exceeds three inches in span. Its caterpillar is of a green colour, and feeds on the leaves of *Eucalyptus viminalis*, forming an oval cocoon of dark-grey silk one inch in length.

*Gástropacha* is represented by seven species, two of which form the bright green silky cocoons found suspended among the leafy tops of Eucalypts. *Eriogaster*, Germ., contains three. Of the NOTODONTIDÆ four species occur, seemingly of the genus *Cnetocampa*, Steph., the caterpillars of which live and feed in great societies, marching out in procession. They pass the chrysalis state either under loose bark or in large nest-like structures among the smaller branches—(a social spider mimics them)—of the trees on which they feed. Great damage is sometimes done by them.

CYMATOPHORA, Tr., furnishes four species, and forms the connecting link between the foregoing and the *Noctuadæ* proper. The latter are rich in species, but often scarcely separable. Among them the following appear, viz. — *Panthea*, Hübn, (*Bombix*, Latr.), with four; *Bryophila*, with one species; *Leucania* contains seven, mostly numerous; *Tryphaena*, Hübn, three (all rare); *Agrotis*, Ochs., fifteen; *Episema*, Ochs., ten species; all of the last genus are very active moths, flying in the glaring daylight of spring and summer.

*Mamestra*, Tr., adds five, and *Rhizogramma*, Led., two species; the chrysalis of the latter is enclosed in a cocoon case formed of grains of soil glued together. *Xylina*, Tr., is represented by two, and the allied form of *Calocampa*, Steph., by one species; all rare. The *Plusiidæ* furnish two species to the collection, but a third is known to exist. The caterpillars of one sometimes attack the potato-plant seriously, feeding at night only, and burying themselves in the loose soil during the day. *Catocala*, Schr., one of our finest moths, and numerous in individuals at times, seems to occur only in one species, while *Halias*, Tr., and *Chlœophora*, Steph., both green coloured moths, and resembling *Geometræ*, present two each. There are three species of *Agarista*, Walk., and one of another allied genus. They are fine black and white coloured moths, flying high and swift during the afternoons of the summer months.

The Geometræ offer great variety in their numerous forms, but with the exception of *Nemoria*, with one rare species coloured green, and one species of *Himeria*, habited in pink and yellow, are of the prevalent sombre hue as the rest. *Zerene*, *Amphydasis*, and *Crocallis*, contain each one species; *Aspilates*, nine; *Gnophos* and *Fidonia*, each nineteen; *Acidalia*, eighteen; and *Numeria*, six species.

The Tortricidæ are represented by about 39 species, but are far outnumbered by the Tineidæ, of which *Lithocolletis* alone, with, perhaps, some near allies, musters 34, all very small, and many distinguished by black and orange colour. Two species of *Tinea* are known to cause and inhabit as larvæ some curious galls in eucalyptus bushes, within each of which several of them dwell at the same time. One or two species are distinguished by a small number of hemispherical protuberances upon their upper wings, near their insertion, arranged in a half-circle when at rest, and glittering like veritable jewels. Besides *Lithocolletis* there are three or four other genera containing 72 species, giving a total of 106 *Tineidæ*. Of Pyralidæ there are six, and of *Alucita* and kindred genera there are five indigenous species. Many more of these tiny *Lepidopters* are known to exist, but have been neglected in the collection, their small size and extreme delicacy offering considerable difficulty in respect of preservation. Yet, small as they are, they are capable of inflicting serious loss at times. One example will suffice. Annually a large quantity of potatoes are destroyed by premature putridity, caused by a host of larvæ of some small *Tinea* forming tortuous canals within the tubers.

## Order Hymenoptera.

Of Hymenoptera, or yoke-winged insects, the province of South Australia possesses a fair share (and, indeed, of at least one family—*i.e.*, ants—rather more than fair), as far as numbers are concerned. According to Dr. Leunis 15,000 species were known in 1868, being at the ratio of three Hymenopters to four Lepidopters, compared with the foregoing order; but as the collection only contains 240 species, giving a ratio of three Hymenopters to five Lepidopters, it proves that this order had not had the same attention paid as the preceding. This is indeed the case, the fact having to be admitted that the ants, Cynipsidæ, and indeed all the small wasps, were greatly but unavoidably neglected for want of leisure and facilities. The remarks made when treating of the Coleopters, in respect of the names mentioned apply to this order likewise.

Of the Tenthrididæ, or saw wasps, the genera *Cimbex* and another are represented by eleven species, the largest of which, golden green with yellow markings, is about an inch in length, the smallest about a quarter of an inch. They chiefly infect eucalypti. The Cynipsidæ, or gall wasps, are very numerous, to judge by the number and variety of galls met with upon many plants, sometimes of exceedingly fantastic shapes; only four species, the largest seen, were collected. Of the Ichneumonidæ, some seasons exhibit quite a crowd; they deposit their eggs in other living insects while in the larval state, and offer one of the most effectual checks to undue increase of any one

Table Showing Families and Number of Genera and Species of Hymenoptera.

| Families. | No. of Genera. | No. of Species. |
|---|---|---|
| 1. Tenthrididæ .. .. .. | 1—2 | 11 |
| 2. Cynipsidæ .. .. .. | 1 | 4 |
| 3. Ichneumonidæ .. .. .. | 3 | 24 |
| 4. Ophionidæ .. .. .. | 1—2 | 21 |
| 5. Pteromalidæ .. .. .. | 1—2 | 4 |
| 6. Chrysidæ .. .. .. .. | 1—2 | 9 |
| 7. Formicidæ .. .. .. | 2 | 29 |
| 8. Mutillidæ .. .. .. | 2 | 44 |
| 9. Myrmiloidæ .. .. .. | 1 | 11 |
| 10. Sphegidæ .. .. .. .. | 4—5 | 28 |
| 11. Crabronidæ .. .. .. | 6 | 31 |
| 12. Vespidæ .. .. .. .. | 1—2 | 8 |
| 13. Polistidæ .. .. .. .. | 1 | 1 |
| 14. Apidæ .. .. .. .. | 3 | 15 |
| Total .. .. .. | 28—34 | 240 |

species in the economy of nature. Some species of the genus *Rhyssa*, represented by six species, are very common, others scarce. Of *Ephialtes*, with two or three near relations, there are seventeen species; some of these are provided with very short ovipositors, others with very long ones; thus the largest of the genus is scarcely half an inch in length, but its ovipositor exceeds an inch and a half. This one is very rare. Of *Pimpla* only one species is known, nearly the same size as the preceding. The OPHIONIDÆ, or sickle wasps, are numerous in most species, of which there are 21, principally appertaining to *Anomala*. The largest exceeds one inch; the smallest is under half an inch.

The PTEROMALIDÆ furnish four, and the CHRYSIDÆ, with some allied genera, nine species, one of which is endowed with strong legs for leaping.

The ants are present in immense numbers, mostly of small size, every inch of the ground in "the bush," except where wet, being haunted by them during the chief part of the year. Some species defy the fiercest heat of the summer; others never appear in daylight. Only a small proportion has been collected yet of *Formica*, distinguished among other peculiarities by comparatively weak mandibles and small sting, the latter frequently quite absent. Sixteen species of the larger kinds have been collected, and of *Myrmica*, with powerful mandibles, terrible sting, and ferocious temper, as many as thirteen. The largest of the winged females of *Formica* is about three quarters of an inch long, but the neuters are always much smaller. They inhabit burrows in the ground with a solitary shaft; hide during daylight, and hunt about by night. The smallest species is less than one-sixteenth of an inch, of a pale ochreous colour, and never appears voluntarily above the ground in daylight. It is often found in farm-houses with natural floors, to the intense annoyance of housewives, the liliputian armies invading sugar, jellies, &c., and tenaciously refuse to quit these substances alive. Among the *Myrmicidæ* are some of the most formidable of their kind, nearly one inch in length, boldly attacking any casual invader of the precincts of their nests, singly and in force, and inflicting a most painful wound with their long stings, scarcely less in effect as that of a scorpion. The popular name "bulldog ants" is a very appropriate designation. Of these there are three distinct species. The allied "jumping ants" have much shorter legs, are, with the exception of one species, much smaller, and can leap several inches. They live in burrows drilled by them in dead branches, and are black; but others, of a clear brown colour with a yellow spot on each side of the abdomen, live exclusively in galleries of still living wood. Another small species with golden green head and thorax dwells under stones and dead timber. It represents the "fire ant" of South America, and, like the others, inflicts very painful stings. The MUTILLIDÆ are numerous. The wingless females of the genus *Mutilla*, represented by fifteen species, resemble the *Formicidæ* greatly. Another genus, a description of which I have not met with, and therefore shall designate provisionally under the name *Myrmiloidæ*, closely mimics the *Myrmicidæ* in form of body, wings, and activity of movements, but differs in having a much smaller head, and the antennæ thread-like and unbroken. They fly about the lights at night, and can sting well. Eleven species have been collected. The genus *Thynnus*, peculiar to Australia, is represented by 29 species, which are very interesting. In Dr. Duncan's "Transformations of Insects," 3rd Ed., p. 217, it is said:—"Verreaux states . . . The male flies about, and "carries the female with him, paying her the greatest atten- "tion, and *placing her in flowers*, so that she can obtain her "nourishment. Frequently other males, which have not the "happiness of possessing a wingless companion, come near and "appear enchanted with her company. Of course *they all* "*become jealous, and should her protector be unable to conquer the* "*others, in order to disappoint them he eats her up*."* This being so exquisite a piece of insect romancing *à la Buffon*, it is hardly necessary to state that I have never observed anything of the kind. What has been observed is simply this: The wingless female is so different in appearance from the male that hardly any amount of experience would enable a naturalist, seeing her for the first time, to recognise her as such, being nearly half the dimensions of the male, and gifted with only very short legs. As soon as hatched she climbs to the top of a high stalk of grass, &c., turns her head downwards and her abdomen away from her support in a sharp angle (say 40 to 50 degrees), thus awaiting the pleasure of some male. The latter flitting close by, whisks her up without any stopping, and carries her about while following his usual avocations. The female clings to his waist or legs until copulation is completed, when she drops off and seeks among the grasses, &c., where to deposit her eggs.

The SPHEGIDÆ were much more numerous, it appears to me, than of late. Then some stray or bold individuals often invaded the interior of cottages for the purpose of building their nests of mud on some rafter or in the corner of a window; now the appearance of one is almost an event of note, except near permanent watercourses. There are four species of *Scolia*, three being large insects; and one of *Ammophila*, which digs holes into the soil with great assiduity, stocking each with

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*** The italics are mine.—O.T.**

a caterpillar heavier than itself. *Pelopæus* musters four species. The smallest lives apparently parasitically in the chrysalis case of a *Promecoderis*, instead of building a nest. *Pompilus*, with one or two allied genera, contains nineteen species, and includes the giants of the order. Of the CRABRIONIDÆ five or six genera occur. *Crabro* and *Cerceris* contain each three species ; *Philanthus*, nine ; *Odynerus*, four ; *Eumenes*, with an ally, seven ; and another genus, resembling *Odynerus*, five. The last differs from its next in kin, by having the third abdominal segment so large that the whole of the remainder of the abdomen can be withdrawn within it, telescope-fashion. Almost all of these exhibit one or other interesting trait of character. To mention one will suffice for the present. So-called "bunged eyes" are of common occurrence during the summer months, but their cause seems still undetected. Now it is well known that at that season certain *Muscidæ* infest the eyes of man and animals very annoyingly. A small *Odynerus* resembling these somewhat in coloration, hunts them and frequently takes them boldly from the human person, dashing boldly among them upon the hand, in the face, or even the eye, wherever they happen to be assembled, attacks one with his sting, grips it with the last pair of legs and flies off with it in less time than it takes to tell. People feeling this unceremonious onslaught, naturally or habitually put up their hand to catch or kill the intruder. If they happen to succeed in arresting it, it is at their cost, for feeling itself held, the *Odynerus* inflicts a sting in return and flies off, for its great hardness saves it from harm. The pain at first is scarcely perceptible, but grows—*creeps*, would be a better expression—rapidly more intense, causing a swelling of the affected part, in which it resembles the sting of certain Myrmicides. So far personal experience goes, but having been curiously free from induced swelling of the kind (even the sting of a bee near the eye left but a very slight trace after the abatement of the first pain), I have never suffered by this malady, and cannot testify to the effect upon others not so circumstanced, yet have frequently seen the *Odynerus* at work near the very eyes of people subject to the complaint. Another point is, that the little insect is especially busy in the early morning of very hot days. Without wishing it understood as attributing to it *in toto* this malady, yet I suspect it strongly as one of the causes. Further, I found that the application of ammonia in the earlier stages removed the pain in a few minutes in several cases, which would prove to some extent that it was due to *some* animal virus, if I mistake not.

The VESPIDÆ number about eight species in one or two genera, some being pretty large insects, but none as fierce as the European species. Of the Polistidæ, or paper wasps, there is one species, which builds its nest under overhanging rocks on the River Murray cliffs, where they are pretty numerous.

The Apidæ or bees are not numerous. There is one large one, resembling *Xylocapa* of steel blue or golden-green hue, forming cells in small hollow branches of trees, not in the collection; three species resembling *Osmia* (one having a proboscis equalling, if not exceeding its whole body in length), and eleven akin to *Megachyle;* total fifteen. Small swarms of the latter, varying in number of individuals from a score or two to several hundred, have been frequently observed on the standing wheat crops towards evening, many laden with pollen. This concludes the account of our Hymenoptera. Fifteen species were obtained at Ardrossan, Yorke's Peninsula, the remainder at the localities indicated before.

## Order Orthoptera.

The Orthoptera of South Australia are not deficient either in number of species, size, or interest; the collection contains 134 species. Most of these insects are vegetarians, and one species of the *Gryllidæ* committed considerable havoc in fields and gardens a few years ago. The Lapiduridæ, or earwigs, muster twelve species in the sole genus *Forficula.* They fold their large transparent posterior wings under very small coriaceous anterior ones, resembling the *Staphilini* among the Coleoptera; among our indigenous species are several which have a small coriaceous patch upon the former, otherwise perfectly colourless, exactly fitting on the square extremity of the latter, thus affording additional aid in protecting the delicate membrane. The Blattidæ, or cockroaches, are rather rich in species, exhibiting twenty-three, besides *Blatta orientalis*, but this introduced pest is fortunately as yet only found in the

Table Showing Families with Number of Genera and Species of Orthoptera.

| Families. | No. of Genera. | No. of Species. |
|---|---|---|
| 1. Lapiduridæ .. .. .. | 1 | 12 |
| 2. Blattidæ .. .. .. .. | 1 | 23 |
| 3. Achetidæ .. .. .. .. | 3 | 21 |
| 4. Locustidæ .. .. .. | 6 | 62 |
| 5. Mantidæ .. .. .. .. | 3 | 12 |
| 6. Hydromantis .. .. .. | 1 | 1 |
| 7. Phasmidæ .. .. .. | 1 | 2 |
| Total .. .. .. | 16 | 134 |

larger ports and towns. Among the native *Blattæ* is one an inch and a half in length, but rarely found in the perfect winged state. Besides this there are several others, never attaining to the winged state. Several species hunt their prey by daylight, living upon bushes, and are exceedingly swift in their motions; all others prefer darkness. The ACHETIDÆ, or crickets, furnish nineteen species. The largest in the collection is about one inch, the smallest less than one-quarter of an inch in length. Most of them live in fissures of the ground, under stones, &c., but several species, distinguished by much reduced posterior wings (sometimes altogether wanting), live upon trees and shrubs, enlivening the surroundings with their exceedingly penetrating chirp. Of tree crickets, gifted with excessively long and thin antennæ and large wings, some very large ones are found, viz., above two inches in span, and the antennæ three to four inches long. They inhabit small hollows, lined with a kind of coarse silk, and appear to be carnivorous. Of *Gryllotalpa*, or mole crickets, only two closely allied species occur in watercourses and in moist situations.

The LOCUSTIDÆ are represented by at least six genera. *Locusta* contains sixteens species, most of which are rare, or even very rare. The body of the largest measures one and a half inches in length, the wings nearly four inches in span. Another, smaller in body, attains five and a quarter inches in span, and inhabits the Murray Flats, near Blanchetown. One species feeds upon the native pine *(Frenela)*, and is distinguished by its yellowish-green anterior wings being marked with numerous black dots; another with white spotted wings frequents *Melaleuca acuminata*, near Ardrossan; another, with pink-coloured wings, and a flat shield-like appendage to the thorax, feeds on mallee, near Monarto. But the strangest of all is a species living upon some Leptospermum shrubs. Its first pair of wings is narrow and of a greyish colour; but the second is large, and beautifully marked with concentric dark bands. These are *rolled* closely together, and form then an angle with the cylindrical abdomen. When resting head downwards (its usual position), it so closely resembles in form and colouration a twig of the shrub, that it is almost impossible to discern it, especially as its long thin legs and antennæ are laid close along the branch and perfect immutability is sustained by the insect. *Decticus* has been found in one species only near Callington. Its posterior wings are of a beautiful pink hue, while all else is green and white. Of *Tetrix* four species are known, fairly large insects, some with very large helmet-like expansions of the head. Of *Œdipoda* eleven species are noted, some of large size, feeding upon woody plants only. *Acridium* is represented by ten species, five of which are from the neighbourhood of Ardrossan; the latter are small, but distinguished by beautiful red, pink, and black coloured posterior wings. *Gryllus* is prominent as the most prolific genus, containing twenty species, one of which (perhaps two) rendered itself notorious by its extensive devastations in 1871-2. Residing at Monarto at the time, I observed an army of these insects several acres in extent. Counting repeatedly the number included in a square foot, it was found that twelve to thirteen in front by eight or nine deep represented a fair average. At this rate the number occupying an acre exceeded four and a half millions! At the same time scores of such armies were met with in the more open parts of the colony, but very few in the mallee scrub. A wingless species of this genus is of very grotesque appearance, and the female about six times the bulk of the male. Another, but small species, has wings, by way of contrast, extending about twice the length of body when at rest.

The MANTIDÆ are represented by thirteen species in three or four genera. The genus *Mantis* contains five species, the largest of which is green and is nearly two and a-half inches in span; the smallest is grey and scarcely exceeds one inch. *Phyllium* furnishes two, both from Yorke's Peninsula; the largest measures two inches in length, two and five-eighth inches in span, with very small posterior wings, and is of green colour; the other is considerably smaller and of a brown hue, the anterior wings marked with a dark spot near the middle. *Cyphocrania* musters five species; the largest female is nearly four inches long and the span of the wings of the male exceeds this. The wings of the females are in some cases scarcely one third of the length of abdomen, and never exceeding one-half; those of the males, on the contrary, are very large and fitted for sustained flight. Their very long legs, upon which the extended narrow body gently sways to and fro, give a spider-like appearance, while their moveable head, with its large projecting eyes, and the devote attitude of the first pair of legs, resembling hands clasped in prayer, add something very human, not belied by their habits. They are the most perfect hunters and robbers, and know well how to hide or to surprise.

A very minute species of HYDROMANTIS lives in the North Para, but resembles the *Phasmidæ* somewhat in the form of its forelegs. It is only three-eighths of an inch in length, and very rare.

Among the PHASMIDÆ, of which three species have been collected, the largest of all South Australian insects occur. This species is five and one-eighth inches long; span of wings, seven and a quarter inches; length of first pair of legs, three and one-eighth inches. The whole of the body, the short anterior (length one and five-eighth inches) and a narrow parchment-like strip of the posterior wings are green, except where the latter are covered by the former, where a fine pink line marks the upper surface of the one and the lower of the other. The covered portions of the large anterior wings are transparent and colourless.

Some 20 years ago this species was rather numerous near Lyndoch, but for many years few have been noticed. Two other smaller species were obtained at Ardrossan. The larger one is of the same form of body as the preceding and also coloured green, but the covered portions of the wings are bright yellow, and the nervures of the remaining parts of the posterior wings are of a rich rose colour crossed by numerous narrow, concentric bands of the same tint. The smaller *Phasma* has a thin elongated body (like a straw) three and five-eighth inches in length and of a reddish brown colour. The transparent posterior wings are tinted along the radiating nervures with many black spots, at almost regular intervals, leaving transparent concentric bands between them. Only one specimen of either was obtained.

## Order Hemiptera.

The Hemiptera, forming two groups, viz., Heteroptera and Homoptera, are quite as well represented in South Australia as any of the other orders, the Heteroptera, or bugs, being represented by 164 and the Homoptera or Cicades by 108 species. The first family of the former, the Pentatomidæ, comprise the genera *Scutellaria* with three, and *Tetyra* with four species, which have their scutellum so enlarged that it covers the whole of the abdomen, and acts as a cover for their wings. These, as most other bugs, are plant-feeders, and some species are very

Table Showing Families with Number of Genera and Species of Hemiptera.

| Families. | No. of Genera. | No. of Species. | Families. | No. of Genera. | No. of Species. |
|---|---|---|---|---|---|
| Heteroptera. | | | Homoptera. | | |
| 1. Pentatomidæ .. | 5 | 81 | 1. Cicadæ .. | 1 | 11 |
| 2. Reduviadæ .. | 2 | 41 | 2. Fulgoridæ .. | 7 | 93 |
| 3. Lygeidæ .. .. | 2 | 16 | 3. Aphidæ .. | 1 | 3 |
| 4. Pyrrhocoridæ .. | 2 | 8 | 4. Coccidæ .. | 1 | 1 |
| 5. Geocoridæ .. | 2 | 8 | | | |
| 6. Nepidæ .. .. | 2 | 2 | Total .. .. | 10 | 108 |
| 7. Hydrometridæ.. | 3 | 8 | | | |
| Total .. .. | 18 | 164 | Total Hemoptera | 28 | 272 |

numerous upon certain native shrubs. Some glitter in most brilliant colours. The genus *Cimex* furnishes the giant of the family, nearly one inch in length, feeding on *Eucalyptus dumosa*, twelve species. *Pentatoma* is most numerous, 52 having been collected. One or two species are notorious as infesting the vine, imparting their objectionable odour to the grapes. This odour is nearly the same for all the members of the group, excepting the *Hydrometridæ*. Another very minute species occasionally attacks the wheat crops to some extent, and has been figured and described by Dr. C. Muecke, M.A., some years ago. *Trichius*, represented by eight or nine species, has the thorax armed with spines; a very small one is furnished with a globular excrescence upon the prothorax.

The Reduviadæ comprise 37 species, mostly of very small size, and are carnivorous, hunting other insects. An allied genus, a description of which I have not met with, is remarkable on account of the singular form of its legs and antennæ. Both are thickly set with fine long hairs, forming in one or two species large brushes on the last pair of legs, which much exceed the others in length. They live under loose bark and in hollows and cracks of trees about Lyndoch, Nuriootpa, &c.; appear to be carnivorous, and are not very numerous. The Lygeidæ, or stinging bugs, are present in several genera, with sixteen species. They can and will inflict a most painful wound, when incautiously handled, by inserting their proboscis. The largest is about three-quarters of an inch in length, but (as most of this family) it is very rare. They hide by day under stones, leaves, &c,, and fly by night. One species is adorned and armed with spikes, and has a very attenuated form of body and limbs. All seem to be carnivorous. The *Pyrrhocoridæ*, eight species, are pretty large insects, vegetable feeders, and sometimes very numerous upon certain eucalypts and acacias. In them the distinctive odour is most prominent, being developed to such extent that the birds refuse them as food, and even the ants appear to avoid their approach. Of *Geocoris*, or underground bugs, eight species have been observed. They live in loose soils, and are not numerous. Of Hydrometridæ, or water bugs, four genera, with ten species, have been noticed. There is one large *Nepa*, or water scorpion, which frequents stagnant water, and is about one inch long; and one still larger, *Ranetra*. Both have long tail bristles, and sting with their proboscis.

Of *Notonecta* four species have been captured. They are found in the calm reaches of rivulets, and fly about at night. *Hydrometra* (*Gerris?*) and another genus (*Halobates?*), with two species each, complete the list of the *Heteroptera*.

The Homoptera, or Cicades, are scarcely less numerous than the preceding group; but several families, notably Aphidæ and Coccidæ, have been unavoidably neglected as far as collecting is concerned.

The Cicadæ furnish eleven species, of which the largest known to me measures several inches in span, is prettily coloured in yellow and brown, and feeds upon *Casuarina* and *Acacia pygnantha*. The next in size is nearly black, feeds upon *Eucalyptus rostrata* and *E. viminalis*, and is common about Adelaide. A third very large species habited in green tints lives about Mount Gambier upon *Acacia obliqua*. A much smaller species is peculiar to the mallee, another with spotted wing to banksias, and a number of smaller ones to various grasses. They are the principal musicians of the Australian forests, but their strains are more loud than pleasant. The *Fulgoridæ* muster seven genera, with 93 species. The typical genus *Fulgora* furnishes only two species, both very rare. *Cercoptis*, only one, but numerous, the larvæ of which produce the so-called "cuckoo spittle." Two genera not mentioned in Reute's "Zoology" are in so far remarkable that the one presents the extreme of lateral, the other of vertical compression. Eight species have been observed, all of which are vegetarians, and their larvæ in many instances exude a sweet liquid, much in request among ants, which lick the same and never hurt either the larvæ or the adults. Several species of *Aphidæ* have been observed upon divers native plants, besides the introduced Rose Aphis. One species feeding among the roots of the wheat-plants attacked by a *Fusidium* (the so-called "take-all"), has been described and figured by Dr. C. Muecke, M.A.; and is in some seasons exceedingly numerous, flying at night towards the light, and adhering in great numbers to the lamps. Another much larger species was observed by me on the roots of some sickly young plants of *Eucalyptus globulus;* it is snow-white, and forms protuberances around the rootlets. A large and beautiful species of *Coccus* occurs in the scrub near Lyndoch and Nuriootpa, and also at Mount Gambier, where it was fairly numerous among the ferns. The female is from one-fourth to more than half an inch in length, exhibiting the usual characteristics of the family, and its body is filled with a bright red fluid. It attaches itself to a twig of *Santalum* or other shrub, inserts its proboscis, and never leaves its place again. The male is much less in size, but gifted with two large glassy wings twice the length of the body, and a tail formed of numerous snow-white silky hairs, giving to the insect when slowly flitting in nearly straight course through the shrubs the exact appearance of a tiny comet, suggesting as most suitable appellation the name of *Coccus cometarius*.

## Order Neuroptera.

The Neuroptera are not conspicuous either for size or coloration, and most genera are also poor in species. Only forty-three species in fifteen or sixteen genera have been collected. Many are insatiable hunters, and therefore useful to man by checking the increase of flies and other insects. The Libellulidæ, or dragonflies, furnish twelve species in three genera, viz., *Æshna*, *Libellula*, and *Agrion*. Many more are known to exist. The Myrmileonidæ, or ant-lions, exhibit thirteen species in three genera. *Myrmeleon* furnishes six species, the largest about three inches in span. The larvæ possess very large mandibles and hide at the botton of small, funnel-shaped hollow, in which ants, &c., are entrapped and devoured. *Ascalaphus*, distinguished by long antennæ with spoon-shaped extremities, is only represented by one species, but the golden-eyed *Hemerobius*, whose larvæ act the lion among aphides by night, musters six. *Raphidia* and *Panorpa* present only one species each; the latter is common almost everywhere in the bush, catching and devouring all day long whatever insects it can manage. *Phryganæa* and *Perla* comprise three species each, and *Ephemera* two. *Mantispa*—so named because closely resembling the Mantidæ in general form—supplies four species, linking the Neuroptera to the Orthoptera. *Semlis* and two other genera only add one species each. The *Termites* are likewise represented by one species only. They are small and found nearly everywhere, but not nearly so destructive than elsewhere. Where undisturbed they form low, conical hillocks, generally marking the site of a stump of some tree. The only native timber withstanding their attacks to any extent is the inner red wood of *Eucalyptus rostrata* and somewhat less *E. viminalis.* Being kept powerfully in check by the *Formicidæ*, their natural enemies, the white ants act rather beneficially by masticating and reducing into fertile humus all animal droppings and decaying vegetable remains.

Table Showing Families with Number of Genera and Species of Neuroptera.

| Families. | No. of Genera. | No. of Species. |
|---|---|---|
| 1. Termes .. .. .. .. | 1 | 1 |
| 2. Ephemeridæ .. .. .. | 1 | 2 |
| 3. Libellulidæ .. .. .. | 3 | 12 |
| 4. Myrmeleonidæ .. .. .. | 2 | 7 |
| 5. Hemerobini .. .. .. | 1 | 6 |
| 6. Raphidiæ .. .. .. | 2 | 5 |
| 7. Panorpini .. .. .. | 1 | 1 |
| 8. Perlidæ .. .. .. .. | 4 | 6 |
| 9. Phryganidæ .. .. .. | 1 | 3 |
| Total .. .. .. | 16 | 43 |

## Order Diptera.

Of Diptera, or flies, a fair number of genera or species occur, while in number of individuals some species are so prolific that probably only the ants vie with them. On account of their fragility of structure, &c., no great attention has been paid to their systematic collection, yet 158 species have been obtained in about seventeen genera. Some species of the Nemoceræ, or long-legged flies, are prominent by their number, thus the genus *Culex* furnishes thirteen species, termed commonly mosquitoes, of which some are only found near water, in which the larvæ live, and others in the driest portions of mallee scrub, suggesting a different course of metamorphosis. All are very bloodthirsty, and on two occasions I observed dense clouds of a very small species (not included in the above number) after sunset near Lakes Alexandrina and Albert, that it became difficult to breathe without inhaling some. *Tipula* furnishes nine species, the largest of which is gifted with legs nearly two inches long, and as brittle as glass threads; it inhabits the Barossa Ranges, and does not attack man. Of *Cecidomyia*, the gall-producing flies, several species exist. An ally, the so-called sandfly, is a very minute insect, scarcely one-twelfth of an inch long, yellowish-grey in colour, and its wings speckled, and is found in cloudlets in sandy parts of the country, flying in the latter part of the afternoon during the spring and summer months. They settle upon any part of a person, move to an exposed part of the skin, and insert their proboscis, thereby causing a pain wholly disproportionate to their size. Each incision produces a minute swelling—producing great annoyance only by their number. The sensation produced may be compared to that of mild scalding. The Asilidæ and their near allies comprise nineteen species,

Table Showing Families with Number of Genera and Species of Diptera.

| Families. | No. of Genera. | No. of Species. |
|---|---|---|
| 1. Nemocera .. .. .. | 2 | 22 |
| 2. Asilidæ .. .. .. .. | 3 | 36 |
| 3. Syrphidæ.. .. .. .. | 4 | 37 |
| 4. Tabanidæ .. .. .. | 3 | 25 |
| 5. Muscidæ .. .. .. .. | 3 | 24 |
| 6. Volucellidæ .. .. .. | 1 | 14 |
| 7. Cecidomyia .. .. .. | 1 | — |
| 8. Leptatænidæ .. .. .. | 1 | 1 |
| Total .. .. .. | 18 | 159 |

including the giants of the order, which inhabit Yorke's Peninsula and adjacent parts, and measure one and three quarter inches in length. All are carnivorous.

*Æstrus* musters eight species, but whether any of them really do attack horses, &c., in order to deposit their eggs upon them, as the typical species, I have not been able to ascertain satisfactorily. *Vermileo* supplies nine species, and links this order to the Hymenoptera, resembling certain species of wasps much in outline, with their highly-coloured attenuated abdomen. *Syrphus* comprises twelve, *Stomaxis* seven, *Sargus* eight species; the latter all of very small size. *Chrysops* furnishes ten species, mostly remarkable for the brilliant colour of their eyes while alive, but fading soon after death. *Holophilus*, with three, and another genus with large hairy body and very small head, with two species, are very rare. The TABANIDÆ, on the contrary, with fifteen species, numerous enough to be unpleasant at times; some species attack man and beast fearlessly to suck their blood. The allied genus *Bombilius*, five species, is not ravenously inclined. The MUSCIDÆ, or flies proper, are well represented by four or five genera, with 38 species. *Gymnosoma*, comprising flies whose larvæ feed in the interior of other living insects, finally destroying their host, are noted with three species, but many more exist. One of this kind greatly assisted in reducing the locusts some years ago, two or three small flies having been observed to issue from dead ones clinging to shrubs, &c. Of *Sarcophaga* seven species have been collected, but only two seem to interfere with human comfort by depositing their young larvæ in meat intended for food. Fourteen species of *Musca* have been obtained, but the actual number may be considerably larger. Several species, including the introduced house-fly, are exceedingly numerous, and increasing in exact proportion with domestic animals—notably of cattle and horses, whose droppings form the domicile and food of the larvæ. A few pounds weight of manure often contains several scores of larvæ of flies. The very small fly attacking the eyes of man with most assiduous impudence during the summer months appears to be a native; it first appears in the woods, and, as the season advances, invades human habitations in the country. *Volucella*, with fourteen species, embraces the largest *Muscidæ*; some are embellished with brilliant metallic hues and changeable tints; some are numerous, but none interferes apparently with man. Of LEPTATÆNA, or ticks, several species are to be noted; they attach themselve parasitically to native animals. The largest observed infests the native opossum, clinging to the inner side of the ear, and is about a quarter of an inch long when gorged; as many as three or four have been seen in one ear.

# THE GEOLOGY OF THE HUNDRED OF MUNNO PARA.

## PART I.—THE NEWER TERTIARY ROCKS.

By GAVIN SCOULAR, Corresponding Member.

### PREFATORY REMARKS.

The Hundred of Munno Para, which has its southern boundary about fourteen miles north of the South Australian capital, comprises, in rough numbers, an area of about 120 square miles. It is bounded on the west by the Hundred of Port Adelaide; on the north by the Gawler River and Hundred of Nuriootpa; on the north-east by the South Para; on the east by Tenafeate and Little Garden Creeks; on the south-east by Gould's Creek; and on the south by the Little Para River.

In descending order, the geology of the entire hundred may be summed up as follows:—First, recent *Alluvium* and *Travertine;* secondly, the *Drift* or *Pliocene*, occupying, superficially, nearly three-fourths of the whole area; thirdly, *Upland Tertiaries*, generally believed to be of Miocene age; fourthly, the *Fundamental Rocks.* The *Miocene* and *Fundamental Rocks* will be dealt with on a future occasion.

### SUPERFICIAL ACCUMULATIONS.

As in many parts over the earth's surface, the most recent geological deposits throughout the district are found on the *flats* of creeks and rivulets, and in other tracts within the district, where causation formerly, or now, exists favourable to collect water-borne material of alluvial character. Collectively the alluvial deposits of the district occupy an area only of a few hundred acres.

*Wind an Agent of Transport.*—Another prime agent of transport carrying on, at present, and through all time, over the *land surface*, a redeposition of the incoherent material we find spread over the surface of the country, which cannot be overlooked, more especially in such a climate as ours, is the action of winds. As proof of this assertion I might here refer the incredulous in this particular to an early inspection of the tiny *sand-drive* accumulated to the leeward of the small grass tussock, and those of more stately proportions bestuding the surface of the country wherever a pre-existing cause intervenes sufficient to arrest the passage of the aerial-borne material. These combined with the decomposition and redistribution of decayed vegetable matter may be said to be the prime agents producing our soils.

*Travertine.*—Next in the series building up the geological structure of the district—or rather I am of opinion, with my friend Professor Tate, they should be included as contemporaneous with the above-named deposits—are those depositions peculiar to our country familiarly known throughout the Province by the term "Crust Limestone." Deposits of this so-called crust limestone occupy considerable tracts throughout the district. In many places it is rapidly forming incrustations a few inches below the surface, whilst in others I have seen it actually intercalated with the soil.

These recent calcareous accumulations must be regarded as aggregations of limy material derived from the débris of older tertiaries, and limestone beds of the older fundamental rocks, together with magnesia derived from the decomposition of clay-slate and other rocks of the old series, reduced to a state of solution by the action of rain and spring-water percolating through the soil and subsoil, and other strata ; then by evaporation the liquid passes off in vapour, and the precipitate forms an irregular incrustation over, or near, the surface. Concentric structures of nodules frequently enclose fragments of foreign matter, land shells, &c. By chemical analysis its composition has been determined to be a carbonate of lime and magnesia, therefore the more appropriate name by which it can be designated is that of "Dolomitic Travertine." To the curious in such matters I will here direct attention to a very fine section—the formation of which was still going on until arrested about 26 years ago by the erection of flour mills over the site—on Smith's Creek, Section 4,160, Hundred of Munno Para.

## Drift.

*Character and Extent.*—Proceeding backward in time, the next formation which will occupy our attention differs essentially from the preceding in so far that it has long ceased actual formative activity ; I mean the *mottled clays* constituting the subsoils of our *plains*, which are for the greater part of a calcareo-argillaceous character.

The deposit extends over nearly three-fourths of the hundred, occupying uninterruptedly the whole of the western portion of the district, as far easterly as Section 2,021 on the Little Para, and Section 1,723, Gawler South. As might be supposed, it does not follow a direct alignment between the points named ; nevertheless, omitting for the present three minor *outliers*, it attains very nearly the same altitude above sea level for the entire distance, presenting as it were a serrated outline along the western base of the Gawler hills. The three exceptions to this general rule, which have come under my notice, occur within the district, viz., in Smith's Creek, and two other minor gullies. These outliers are found resting far within the general profile of the western escarpment of the range, and have an elevation of about 550 feet above sea level; whilst the maximum height of the main field of these deposits is about 150 feet less.

*Denudation since the Deposition of the Drift.*—The existence of these detached masses demonstrates the vast extent of denudation that the Drift has been subjected to. In short, when we consider that these outliers formed once an integral part of the deposit of the neighbourhood, and also the difference of their level over that of the main sheet, we cannot help inferring that denudation since the era of the deposition of the *Drift* must have abraded from the western slopes of the Munno Para Hills material to the extent of at least 150 or 200 feet in vertical measurement.

*Depth and Water Supply.*—The mean depth of the formation, so far as I am aware, has not yet been ascertained. No shaft or bore has been put down in any part of the district, unless in search of water, the line of which, over that portion termed the lower plain, can be pretty accurately determined from the rise and fall of the surface. The water, though often not good, is obtained in many instances at the depth of a few feet from the surface, whilst in the neighbourhood of the Gawler Railway Station it is not reached at a less depth than from seventy to eighty feet (and in one well in the immediate vicinity the water is very salt). The water obtained from wells in Gawler South and West is generally of very good quality; at present, however, I cannot speak authoritatively of the character of the potable water bearing stratum, but that of the saline one is immediately under a bed of highly water-worn pebbles, from the size of a man's head to that of a pigeon's egg, conglomerated imperfectly together by an incoherent arenaceo-argillaceous paste.

Though the water-line, throughout the lower reaches of the plain, can be pretty much depended upon, yet no such regularity prevails in the upper. As an instance of such irregularity I may mention that the water-line immediately around the Smithfield Railway Station does not exceed fourteen feet; whereas at the Inn, about 600 yards distant, it is upwards of seventy feet, the difference of surface level being less than twenty-five feet, and of the water-line of the wells more than thirty feet. Besides the difference in level their is a difference in the properties of their water, as per analyses supplied me by Mr. A. Thomas, F.C.S. :—

| | I. At Railway Station. | II. At Inn. |
|---|---|---|
| Sulphates.. | 0·62 | 0·48 |
| Chlorides .. | 5·60 | 11·20 |
| Total grains per gallon .. | 6·22 | 11·68 |

This difference leads me to infer that the supply is derived from totally separate local sources; I say local, because in neither case can the supply be derived from the general source or reservoir from which the wells of the lower plain are supplied, the water level of which is, at least, forty feet lower in the series than either.

As we approach the hills a very different phenomenon is presented. In no instance—unless from winter soakage at the outlets from the hills of a few gullies—have any previous attempts to procure water by sinking into the so-called drifts been successful. About twenty or twenty-one years ago the Hon. Thomas Hogarth put down two shafts in Section 4,151; also about the same time the late Mr. Alexander Cullan put one down in Section 3,205 (reference to map of the district will show that Mr. Hogarth's and Mr. Cullan's trial shafts were distant, as the crow flies, from each other about four and a quarter miles), and in each case—twice by the former and once by the latter—were the variegated clays of the formation pierced at a depth of about eighty feet. In subter-position to this eighty feet of calcareo-argillaceous material was found a semi-consolidated white-yellow siliceous sandstone, and though I am not prepared to state to what depth it was penetrated in the late Mr. Cullan's shaft (not less than twenty-five to thirty feet), yet the Hon. T. Hogarth informs me that in one instance on his estate at Smithfield it was perforated to a depth of forty feet without any visible sign of change. No *well*, in the true sense of the term, can be obtained in this exceedingly permeable stratum until a more impervious material is reached; which in all likelihood will not be at less depth than 170 feet. But because the nearer we approach the hills the more saline the character of the water becomes, I venture to predict that the water obtainable from this source will be nearly as salt as the sea itself. However, the effect of this buried sandbank is to produce a comparatively waterless subterranean tract skirting the base of the Munno Para Hills.

*The Origin of the Drift.*—Let us now briefly inquire into the nature of the agency to which these beds owe their deposition. It has been advanced by our esteemed friend Professor Tate, of the Adelaide University, that our South Australian *Drifts* owe their deposition to ice action. And why not? But before the mind can be persuaded to accept that theory it must be prepared to admit that when glaciers slid from the summits of the Gawler Hills to be borne away in the shape of icebergs upon the waters of some nameless inland lake, upon the floor of which the earthy burden of these supposed ice-streams were deposited, the contour and profile of the surrounding country must have been very different from that we at present see. To obtain glaciation of the Gawler Hills, one or other of the following natural conditions must have prevailed:—(1) A change of the present position of the poles of the earth; (2) or that our sphere was passing through a more frigid region in space than now; (3) or that the heat-producing properties of the sun for the time being became greatly diminished; (4) or that the Gawler and neighbouring hills had an elevation sufficient to retain the aqueous vapours reaching their summits in a state of congelation; (5) or a shifting northerly of the belt of trade winds. In short, one or other of such must have been the ruling state of nature before any part of the Australian continent could be wrapt in a mantle of ice. My present object is to deal only with the subject locally, and so far as the evidence that Munno Para supplies the problem is left in a state somewhat as follows:—It is true that no remains of marine life have as yet been discovered in these beds, and though it is regarded almost as a recognised maxim by the geologist and paleontologist that deposits from which no fossil remains have been exhumed are not of marine origin, yet I am of opinion that whilst many of that class of scientists advance that theory as very good negative evidence, few, I presume, would for every case be prepared to uphold such as a positive occurrence. Though this seeming unfossiliferous state of things so far as known really does prevail throughout the Munno Para *Drifts*, yet we must bear in mind that necessary conditions are required to ensure preservation after death, in a somewhat similar degree as to sustain existence during life; and that shore-lines, more especially those of a bold character, must in my opinion be still less adapted for the preservation and retention within their sediments of animal forms, either in a fragmentary or entire state, than those of a less abrupt outline. If we reflect for a moment on the small tithe of living forms that have been preserved and handed down to us in a fossil state, even in beds most prolific in fossil forms, we should wonder less when we find them to contain no animal remains; and we are apt to conjecture such beds were laid down under such and such conditions, unwittingly overlooking the important fact that their non-fossiliferous appearance is not because animal remains are not present there, but because they are not there in a palpable state.

But to return from the suppositionary to a more tangible line of argument. The Munno Para *Drifts*, though regarded non-fossiliferous, and consequently with great probability were of fresh water origin, yet they present features which should lead one to a somewhat modified decision. The waters with which these *Drifts* are surcharged in five cases out of six are found to be impregnated less or more with saline matter, some of them to an extent altogether rendering them inappropriate to animal use. Such being the case, an impartial juryman would naturally conclude had the beds in question been of glacial—which amounts to the same as their being of fresh-water origin—being aware also that the waters with which by far the greatest extent of these beds is at present, and has been for thousands of years past, surcharged, must necessarily be rain-water, that they should not now so frequently produce waters of a saline character. Secondly—Pieces of charred timber, analagous to that still growing in the adjacent hills, have on several occasions been found by me imbedded in these deposits at a depth of twelve feet from the present surface, proving, pretty conclusively to my mind at least, that glaciers did not occupy the summits of the Gawler hills at the period of their growth, as none of the present species of the *gum tribe* could have withstood the severe cold which necessarily must then have prevailed. No *striated pavements*, either, or transported boulders, presenting the least sign of ice-action, have as yet been discovered throughout the entire area of the *drift* of Munno Para or neighbouring hills, though real water-worn pebbles are found to occupy a position nearly in every section where the base of the formation is exposed, as it thins out against the western slope of the hills.

Such is a brief outline of the evidence Munno Para supplies as to the glacial, or fresh-water origin of our South Australian *drift* deposits. Whilst the drifts of Munno Para yield nothing that could warrant the assumption that the *drift* formations of the colony were the outcome of a cold and pluvial period; yet we have, nevertheless, slight evidences of ice action presented in a few places throughout the Province such as the *striated pavement* at "Hallett's Cove," and the *transported boulders* associated therewith. But the scanty evidence that these mere outliers of information render, ought for the present to be accepted with great caution. The phenomena of striation of rock surfaces and boulders of foreign character have often been found to have arisen apart from the direct outcome of glaciation; and, therefore, I am for the present inclined to regard them as such; and although the conditions under which our drift deposits are laid down be still, at least to me, an inscrutable enigma, nevertheless I will venture to put forth a theory, which, though not new to science, is, so far as I am aware, new in application to this case, whereby it is not only probable, but very possible, that our comparatively recent *drifts*, which occupy considerable tracts of the lower situated lands of South Australia were laid down.

The great philosopher, Laplace, was the first to demonstrate the fluctuation of sea level. In short, he was the first to advance that the level of the ocean was regulated entirely by transference—on a grand scale—of solid matter from one part of the earth's surface to another. The same theory was revived about ten or twelve years ago by Dr. Croll, of the Geological Survey of Scotland, and subsequently accepted by Sir William Thomson, F.R.S. It would be presuming too much, on my part, to enter here in detail upon matters with which a majority of members present are fully acquainted. Allow me, however, to state this much that Dr. Croll and Sir William have penetrated into the mystery so far as to enable them to advance the opinion that our earth undergoes long secular changes of summer and winter, brought round by some natural law, just as truly and surely as that regulating the change of our annual summers and winters.

Treating on this subject, Dr. Croll expresses himself in the following words:—"When the eccentricity of the earth's orbit is at a high value, and the northern winter solstice is in perihelion, agencies are brought into operation which make the south-east trade winds stronger than the north-east, and compel them to blow over upon the northern hemisphere, as far probably as the Tropic of Cancer. The result is that all the great equatorial currents of the ocean are impelled into the northern hemisphere, which thus, in consequence of the immense accumulation of warm water, has its temperature raised, and snow and ice to a great extent must then disappear from the Arctic regions. When the precession of the equinoxes brings round the winter solstice to aphelion, the condition of things on the two hemispheres is reversed and the north-east trades then blow over upon the southern hemisphere carrying the great equatorial currents along with them. The warm water being thus wholly withdrawn from the northern hemisphere, its temperature sinks enormously, and snow and ice begin to accumulate in temperate regions. The amount of precipitation in the form of snow in temperate regions is at the same time enormously increased by the excess of the evaporation in low latitudes resulting from the nearness of the sun in perihelion during summer."—(Geological Magazine, Decade II., vol. V., p. 397.)

Dr. Croll sums up his argument as follows:—"The final result to which we are, therefore, led is that those warm and cold periods, which have alternately prevailed during past ages, are simply the great secular summers and winters of our globe, depending as truly as the annual ones do upon planetary motion, and, like them, also fulfilling some important end in the economy of nature."

From the foregoing quotations, it will be observed that the effect of such changes, while the south-east trade winds are attaining their maximum value, by their continued urging forward of the warm waters of the tropics into the northern hemisphere, is to raise the temperature of these regions; consequently the accumulated snow and ice of ages in that hemisphere will disappear. Though not quite so at present, I imagine if reckoned by a lengthened period of time, the heat derived from the sun must be pretty equally divided over both hemispheres. Nevertheless, when it becomes diverted—as in the manner pointed out by Dr. Croll—by an indirect agent, as it were, from the southern into the northern hemisphere, though the cold in the former may be setting in almost imperceptibly, it must necessarily be diminishing, in a corresponding ratio, in the southern. Briefly, sufficiently so, if prolonged for a lengthened period, to produce a glacial epoch —down at least to the 45th degree of latitude—over the southern hemisphere.

Let us now inquire a little more in detail what effect such a state of things would produce. "We have no reason," remarks Dr. Croll, referring to the glacial epoch of the northern hemisphere, "to believe that the total quantity of ice was much greater in the globe than at present, only it would then be all on our hemisphere." Few, I think, will venture to gainsay the philosophy in that statement; and, as I have already stated, the sun's heat, if considered by lengthened periods of time, will be distributed equally over both hemispheres. Whilst the north is sustaining a frigid condition, the south must necessarily be receiving more than its fair equivalent of sun's heat; to restore, therefore, uniformity or equal distribution, the south must pass through a frigid condition also. If we at all can be guided by the opinion of such minds as Archdeacon Pratt, the Rev. O. Fisher, and the author just quoted, then were the ice now accumulated over the northern hemisphere transported into the southern, it would have the effect of displacing the earth's centre of gravity sufficiently to submerge the southern shores of Australia to the extent of something like 600 feet. It was whilst the southern hemisphere was passing through one of these protracted winters that we must look to as the age of *Drifts*. Not that I believe they were laid down through the direct agency of ice—for we have no evidence, unless in cases where altitude can be shown to have acted as the ice producer, that the general ice-sheet has descended in either hemisphere far below the 45th degree of latitude—and we have no data to warrant the supposition that Australia has passed through any elevatory ordeal since long anterior to the era of the Drift. Nevertheless, apart altogether from elevation having anything to do in the matter, whilst the cold period was approaching to and receding from its maximum value, for countless ages probably a continual frigidity prevailed over the southern hemisphere at no greater distance from our southern shores than ten degrees. Australia then must have witnessed a very different climate than she now enjoys. Though we have no reason to infer other lands in the southern hemisphere then existed than do at present—and these, according to Dr. Croll's theory, would then attain a proportionate lower altitude above sea level as their situation approached the south pole—yet it might be reasonably inferred that sufficient dry land did then exist to produce icebergs of enormous proportions. Existing lands are the South of New Zealand, Sibrina Land (situated about 1,600 geographical miles due south of Australia); Cape North, in South Victoria Land, though situated fourteen degrees east of Adelaide, is only 35 degrees, or 2,160 geographical miles south of the parallel of that city; besides other minor islands to the south-west and south-east of Australia. Likewise we must bear in mind that though no land nearer to Australia than New Zealand would present an actual ice cliff from which mountains of ice would be discharged. Nevertheless, at least down to the 45th degree of latitude, the surface temperature of the ocean for something like eight months in twelve would be, if not quite, pretty near that of the freezing point, which would tend in a much greater degree than at present to facilitate the passage of icebergs discharged from southern lands much further north than now transpires. To my mind, in those days the stranding of icebergs on the southern shore line of Australia would frequently happen, and to that cause I venture to ascribe the phenomena of the presence of *erratic boulders*, and probably also the *volcanic bombs* found strewn along our present coastline and elsewhere throughout the *Drift*.

Though I cannot fully hold with those who are of opinion that the South Australian drifts are purely of fresh water, or purely of pluvial origin—and also I may here state I by no means disregard the potent fact that depressions and elevations of the earth's surface in various degrees beyond our conception have and may still be caused by the action of internal agency—nevertheless a careful investigation of the various points at issue in the case before us leads me to conclude that the conditions under which our *Drifts* were laid down were brought about by "planetary motion." We might also point out at the time when the land of Australia was depressed to the extent of 600 feet below the present sea level our land must have presented a much more diversified insular aspect than now. Moreover, in conjunction with that coincidence, the southern hemisphere being also passing through one of its protracted winters, would lead us to infer a much greater annual rainfall then than we now witness, which in a corresponding ratio would act more extensively to denude and transport to lower situations material building up the once by far more extensively developed *Older Tertiaries.* Ample evidence is still presented, from the presence of numerous outliers, of their once general prevalence throughout the uplands of Munno Para and adjoining districts.

*Probable age of the Drift.*—As to the question, What is the probable age of our comparatively recent accumulations? I am of opinion that they are older than the boulder clays of the northern hemisphere. No data have been given to show that sufficient oscillation of the earth has taken place since the era of the Northern Drift to warrant a belief that a depression of something like 600 feet so far down as latitude 35 degrees has occured in either hemisphere. Anterior to the period of the northern "boulder clay" we have strong evidence advanced—the *Buried River Channels* of Great Britain and other northern countries—that the land over a great part of that hemisphere stood much higher in relation to the sea than it does at present. Therefore, if the theory upon which my argument is based be correct during the geological epoch immediately preceding the glacial, whilst the land in the northern hemisphere stood higher it accordingly would stand lower in the southern, in all likelihood it was during that round of time our so-called *Drifts* were deposited.

We might also—I think with some degree of propriety—refer the age of our "Marine Limestone Crust" of Dry Creek Junction and elsewhere throughout the Province as being contemporaneous with the period of the growth of the now *Submarine Forests* and *Peat-beds* of Europe, which Dr. Croll considers to have flourished about 22,000 years ago.

### Explanation of Hand Specimens.

No. 1. Hand specimen of Travertine, or Calc-tuff, from the bed of Smith's Creek, Section 4,160. Substance arranged concentrically around a common centre. Many of the layers, it will be observed, are much denser than others. The darker ones may have derived that hue from an intermixture of the finer particles of dark vegetable mould, caused intermittently either by the action of winds or flood-waters whilst the concretive process of the limy matter was in progress.

No. 2. From the same place. Very much less compact in structure. The denser side represent the upper *in situ;* consequently it has always been exposed to aqueous and aerial influence.

No. 3. Foliated Travertine. From observation I am inclined to infer that this structure of travertine occurs most frequently where the formation closely approaches the surface, or is altogether exposed. Section 4,160.

No. 4. My observations lead me to believe that the segregation of these structures from the surrounding Drift material progresses more rapidly when the subsoil, which is the stratum in which they generally occur, is by some means for the time being exposed to the atmosphere. Southern side of Section 4,159.

## INTRODUCTION TO THE

# CLIFFS AND ROCKS AT ARDROSSAN, YORKE'S PENINSULA.

By OTTO TEPPER, Corresponding Member.

The geological formations at Ardrossan, situated on the eastern coast of Yorke's Peninsula, present some interesting points, there being preserved here, not only deposits of the oldest Tertiary formations hitherto known in the southern parts of South Australia, but others showing more or less metamorphic action and fossil remains, adjacent to rocks of a highly crystalline character resting upon granite or intruded by it. Though all the rocks mentioned in this paper may be studied at some point or other within a mile or two of the coast, yet the difficulties in the way of exact determination are considerable, there being few places where underlying strata are exposed, hill and dale inland being mostly covered with dense mallee scrub, or, where this is absent, the almost universal surface limestone (travertine) and clay veil the older deposits. Thus a good deal has to be inferred from what can be observed at distant localities.

The accompanying plans, diagrams, &c., illustrate the results of my observations. Fig. 1 is a plan showing the topographical details of most deposits, as observed at the surface. Fig. 2 represents the relation of the strata in the direction of the line forming the northern boundary of Section 77. Fig. 3 represents the intercalation of some limestones and a silicious rock not observed elsewhere and to be described in due course. Figs. 4 and 5 illustrate details of the uppermost portion of the fossiliferous Tertiary rocks; fig. 4 showing the first appearance of the "Turritella grits" *under* the "Ardrossan clays and gravels;" and fig. 5 the several constituent layers of the same, being chiefly interesting on account of the fact that the "Ardrossan clays," while at Ardrossan forming the foot of the sea cliffs, the "grits" appear at the summit—here suddenly assume the place of the upper portion of the "grits," ending abruptly, but not divided by any *distinct* line of demarcation, which has induced me to consider these characteristic red and white clays as the lowermost member of the newer Tertiary strata, produced by the disintegration of the older Tertiary rocks.

## Newer Tertiaries.

The surface soils of the less elevated tracts along the coast and in the interior are recent deposits, formed by the disintegration of the rocks of the locality. They consist either of a sandy loam or else an adhesive clay, varying from six to fifteen inches in thickness (figs. 2 and 3). Limestone concretions succeed these, varying in thickness from one to eight feet, and consist of a more or less intimate aggregation of sub-globular bodies from the size of a pea to that of billiard balls, and larger. Where closely cemented they form the so-called "Limestone crust" of the lower parts, sometimes apparent on the surface, where the soil has been removed by atmospheric agencies (fig. 2 under "Ardrossan"). Another kind of limestone, viz., Travertine, is found on the summit of the hills and on their sides, but always in situations nearly horizontal. It occurs in thin layers, denser, heavier, and darker in colour than the preceding, and frequently containing numerous fragments of the oldest rocks of the neighbourhood, sometimes sharp-edged and sometimes rolled. (Figs. 2 and 3 centre, and on hill top.) Both limestones seem to be of recent formation, but the latter appears to be the older on account of its greater density, and formed probably under different conditions, for example, greater abundance of water. In neither have any fossils being detected.

## Pleistocene.

The section of the coast cliffs (fig. 2) shows below the concretionary limestone a series of clays and gravels, containing pebbles of granite, hornblende, mica slate, sandstone, &c., and also of the Tertiary grits with their characteristic fossils. False bedding is observable throughout, proving a turbulent state of affairs during deposition. Amongst the *adhesive* clays of this series thin, parallel bands of white pipeclay appear frequently, to the number of three or four, and are persistent for considerable distances. The total thickness of this stratum may be estimated as ranging between twenty and thirty feet. It is, for reasons indicated above (principally as containing pebbles and fossils of Older Tertiary rocks), certainly of more recent origin, but whether it forms an upper member of the Middle Tertiaries or be of Post-Tertiary origin, is uncertain, as no fossils have been observed.

## Older Tertiaries.

*Ardrossan Clays and Sand-rock.*—The stratum underlying the preceding (apparently conformably) consists of variegated red and white arenaceous clays and sand-rock, interstratified with gravel bands of very characteristic aspect. For this reason they are designated "Ardrossan clays" in the accompanying sections, &c. The boundary between this and the preceding stratum is not very distinct, when viewed closely; but is quite conspicuous when seen from a short distance. Throughout their whole vertical extent the part of the cliff, formed by these clays, exhibits when dry a vertical cleavage like starch. The enclosed fragments in the bands of sand and gravel are of all sizes and degrees of wear, notwithstanding the difference of hardness of such rocks as granite, mica slate, &c., and suggest the idea that the whole has not been transported hither from distant localities, but produced by the chemical disintegration of a previous rock of lower Micene or upper Eocene age, as testified by the fact that the largest fragments occur at almost regular levels, containing numerous fossils and casts, principally of *Turritella Aldingæ* (Tate), characteristic of the succeeding layer, to be described hereafter. The whole being strongly impregnated with saline ingredients, everywhere perceptible to the taste, and frequently forming a glassy crust upon the face in protected localities, appears to strengthen materially this assumption. What these saline substances are, has not been ascertained, but they do not appear to consist of pure chloride of sodium; efflorescences of these have been observed forming stars of needle-like crystals, colourless, transparent, and diverging under a low angle. Some *Turritellæ*, &c., and an Echinus have been found at various levels, and not damaged by rolling or grating, which would have been the case had they been carried hither by currents of water. Having observed these clays in one locality overlying the succeeding bed conformably, at another abruptly taking the place of the upper portion (figs. 4 and 5) thereof, has induced me, together with the other observed facts mentioned above, to consider them as the uppermost member of the Older Tertiary strata. Their maximum thickness does not exceed, where observed, fifty feet, while the parallel average may be about twenty-five to thirty-five feet.

*Turritella Grits.*—Ascending from Ardrossan any of the neighbouring low hills we meet near their summit with fragments of a peculiar fossiliferous rock, the "Turritella grits," as I propose to name it. It is a silicious rock of very variable aspect, passing in density through all stages between opaline or chalcedonic grit to soft, friable sand-rock, most frequently having an intermediate character, very hard and very brittle. Near Ardrossan and northward to Clinton (15 miles), it occurs near the summit of the hills, occasionally capped by the travertine limestone, seemingly in no relation to the clays, as no section is available *in loco.* But southward between Rogue's and Muloowurtie Points (fig. 4) the same rock appears (in the beautiful section represented by fig. 5, and forming miles of romantic cliffs) *under* the foregoing strata in its own true colours in extended thin broken bands of grit containing (nay even almost formed of) very numerous casts of *Turritella Aldingæ* (Tate), several bivalves, &c., and alternating with bands of marl, clay, sand, &c., of about equal, but sometimes larger, dimensions, viz., varying between a few inches to a foot and a half, as partially illustrated by figs. 4 and 5, outline sketches of part of the face of the cliff between Rogue's and Muloowurtie Points. For fossils the immediate neighbourhood of Ardrossan has been well examined, and casts and impressions of a limited number of molluscs obtained, viz., *Turritella Aldingæ* which occurs in immense profusion, and its casts (frequently found delicately moulded in hyaline quartz, resembling fairy corkscrews), sometimes form the largest portion of a rock specimen; other univalves, occurring rarely, are species of *Voluta*, *Cassis*, *Natica*, *Cypræa*, *Dentalium*. Of bivalves several species of *Pecten*, *Chione*, and *Pholas*. *Holaster*, and one or two of other species, a cast of *Pentacrinus* (small), and numerous fragments of *Eschara* and *Retepora* nearly exhaust the list. An impression of a leaf of some dicotyledonous tree (*Cinnamomum* probably) and three specimens of fossil wood of as many species complete the catalogue of vegetable remains found.

These "Turritella grits" seem to occupy a narrow strip along the coast, having been observed only for about one mile to one and a half miles inland, occupying everywhere the position illustrated in figure 2, viz., at or near the hilltops from a point a little south of Ardrossan to near Clinton, where it was observed at a single place, but not ascertained whether extending farther north; while below the line of sea level, at a place further south, near Rogue's Point, it emerges at a low angle (two or three degrees) from below this level (fig. 4) underlying the Ardrossan clays and gravels. The only way this can be explained appears to be that during the close of the deposition of the local Tertiaries, and preceding or during that of the Ardrossan clays, an upheaval of the northern part of Yorke's Peninsula took place which did not affect the region extending to the south of Rogue's Point. The Turritella grits occur at Ardrossan, apparently above a felspathic sandstone. This rests upon marbles, which are succeeded by undoubtedly Palæozoic rocks, finally abutting upon a granite which extends—to judge by the character of vegetation—to within two miles of Maitland, where the gneissic rocks and the same felspathic sandstone again appear.

*Muloowurtie Clays.*—The succeeding layers to the "Turritella grits" appear to be absent at Ardrossan, except the next underlying it, which on account of the difference of level between the upper observed surface of the sandstone mentioned (to be described hereafter), and the lowest part of the "grits" has been introduced in fig. 2 under the name *Ochreous Clay*, but as this and the other deposits are seen at another locality in normal juxtaposition, the following applies to the same, viz., the coastline in the Hundred of Muloowurtie, between Rogue's and Muloowurtie Points.

About one and a half miles south of Ardrossan, the strata forming the coast cliffs thin out or curve downwards to within a few feet of high water mark, and re-appear afterwards at Rogue's Point with an ascending angle of about two or three degrees, measured in the direction of the coast, viz., nearly N. to S. Two miles further the whole series shows several curvatures, the height of the cliff at the same time decreasing rapidly from 70 or 80 feet to fifteen or twenty, and close by marbles appear above the sea level underlying unconformably the above. Near Muloowurtie Point a peculiar sandstone occupies locally either the lower part of the "Ardrossan clays" or the upper of the "Turritella grits," most likely the latter. It consists of small, equally-sized round grains of pure silica, resembling very much, where weathered, the roe of fish. Its dimensions vertically are inconsiderable, being only a few feet in thickness, and contains no fossils.

Some distance further south a thin layer of ferruginous sandstone appears instead, containing abundantly casts and impressions of large *Turitellæ* and small bivalves (cockle-like). In structure it resembles exceedingly the so-called Upland Miocene ironstone near Tanunda, Nuriootpa, &c.; but at these places *no* undoubted fossils as far as I know are associated with the same, excepting some specimen of wood transformed into oxide of iron, obtained by me. A similar rock has been observed by me, but without fossils, in a small patch in Section 214, Maitland, Yorke's Peninsula. Between Rogue's Point and Muloowurtie Point the base of the series of older Tertiary strata occurs at sea level, resting on the Ardrossan Marble, and is succeeded by the rest up to the "Turritella Grits" at 40 feet elevation. The "Turritella Grits" have (fig. 5) here a thickness of some 20 feet, the greatest measured vertical thickness being 26 feet 6 inches; and consist of two or three distinct unfossiliferous clays and bands of grit from three inches to a foot in thickness, the uppermost and the lowest of which can be traced for long distances, while the intermediate ones partly change into white marls or cease and re-appear irregularly, or disappear altogether. They alone contain fossils, and all of the same description. Immediately, below and conformably thereto, follows a layer of ochreous clay (fig. 5) without fossils, and of a thickness (where measured) of six feet six inches, but much more at other places. This overlies, likewise conformably, a soft, arenaceous, yellow clay, changing to sandrock of variable dimensions, viz., from nine to twenty feet. From it have been taken specimens of *Terebratula* and other molluscs, all totally different from those of the Grits. It is succeeded by a whitish, plastic, sandy clay, or clayey sand, abruptly separated from the preceding by a seam of hard arenaceous limestone only one inch thick. This bed contains numerous small fossils, *Fibularia gregata* (Tate), small Pectens, &c., and overlies a yellow clay, containing abundant specimens of *Ostrea*, *Avicula*, *Pecten*, *Echinoderms*, &c., and even some teeth of fishes have been obtained. It seems a remarkable fact that the fossils in these lower layers should have preserved the original structure of their shells, though very brittle; while those in the upper grits have been changed into silicates, or dissolved away.

At Muloowurtie Point the last-mentioned clay rests directly and unconformably upon the crystalline limestone called "Ardrossan marble" (C, fig. 2) in undulating curves, and several of the upper members of the series thin out and disappear gradually. The total aggregate thickness of the whole series of the lower clays may be estimated at not much exceeding 40 feet, where observed. As to what age these lower clays belong, the following remarks may not be out of place:—Some specimens of the "Turritella Grits" having been submitted to Professor Tate, F.G.S., President of this Society, I was favoured by him with the information that he identifies their characteristic fossil with that of a member of the lowest fossiliferous series at Aldinga, the oldest Tertiary strata hitherto known in South Australia, and belonging to the Eocene period; therefore, as none of the fossils hitherto discovered in the lower clays at all resemble those of the grits, and embedded in a lower stratum, these clays may ultimately prove to be of still greater age.

## Lower Silurian.

At the elevated parts near Ardrossan the local Tertiaries overlie unconformably, as stated above, a firm, felspathic sandstone and grit, designated "Ardrossan Sandstone" (B, figs. 2 and 3). This sandstone is sub-crystalline in texture, fine grained in the upper, and coarse in the lower portions, and of greyish white colour, and occasionally coarse and even conglomerate. The upper portions show false bedding distinctly, and separate into large blocks, while the lower present a distinct cleavage at nearly right angles to the plane of deposition. It is quarried on Section 77 (see fig. 1) for building stone, for which it is well adapted. The measurements taken there gave the following angles, viz.:—Dip, 15 degrees easterly (average), and strike N. 63 degrees E. The same rock also forms escarpments on the seaward faces of the hills in Sections 33, 31, &c.,

overlying unconformably for some distance directly the Ardrossan Marbles. Its thickness seems nowhere considerable, 20 feet being probably the maximum. Throughout the whole extent of this sandstone no fossils have been observed, except some holes resembling those of *Pholads*.

South of Parara Station, Sections 31, 22, 21, &c. (fig. 1), some peculiar strata intervene between the "Ardrossan Sandstone" and the Marbles, viz., a variegated and a dark-coloured limestone, and white and yellow marbles (fig. 3), conformable with the "Ardrossan Sandstone" and each other, but unconformable to the marbles. The planes of stratification are so obliterated in the exposed portions, that their angle of dip has only been surmised from the general agreement of their exposed faces in vertical distance from each other and the "Ardrossan Sandstone," in any section from E. to W. But this is not the case in the direction N. to S.; on the contrary, here the lowest bed appears first on the summit of the hill in Section 31 (see fig. 1), and subsequently the others, attaining gradually larger dimensions. In Section 21, to which only my observations extend, the lower white and yellow crystalline limestones occupy the lowest depressions, concealing the marbles entirely. Not having at all observed it further south, it seems to be of local occurrence only, perhaps filling up an ancient valley or basin; but my observations are not sufficient to pronounce a decided opinion. Both varieties of the upper marbles contain distinct fossils and abundantly minute fragments of such, but the upper one by far the most, conspicuous among which occurs a trilobite, and coral structure appears to perfection in sea-rolled pebbles, when the fossil shows in beautiful contrast of colour upon the smooth surface. Professor Tate holds the tentative opinion that the fossils are of Lower Silurian age. The dense, light-coloured marble seems to contain no fossils.

## Pre-Silurian.

The "Ardrossan Marbles" form the basement rock from Ardrossan to Muloowurtie Point, along the coast. They consist of yellowish or pink coloured (*not* variegated) saccharoid limestones (figs. 2 and 3) with well-developed jointing and obliterated stratification. At the surface disintegrated to a rubble, a short distance below they form large solid blocks, seemingly well adapted for ornamental building material, being capable, on account of their fineness and density, of receiving a beautiful polish—especially the pink variety. An almost limitless supply could easily be obtained. At Muloowurtie Point, where it forms the foot of the cliff at and below sea level, this limestone is interstratified with a curious cellular iron ore, assuming, by atmospheric and wave action, a metallic polish, exhibiting finely the irregular reticulated structure. No fossils have been observed (dendritical moss-like figures cover, more or less profusely, the cleavage planes). The thickness of the stratum is very considerable, but has not been ascertained numerically. Dip $59\frac{1}{2}$ degress easterly; strike N., 8 degrees E.

The costeening pits of the Parara Mine reveal the upper portion of grey Micaceous Slates, extending for several hundred yards E.W., otherwise concealed by the surface deposits. Dip, $59\frac{1}{2}$ degrees to 71 degrees easterly; apparent strike, N., 5 degrees W. A dark talcose schist occurs in the talus of the same mine. (Figs. 1 and 2.)

The Micaceous Slate is succeed by a dark green Chloritic (or talcose) and Hornblendic schists, several hundred feet thick, with an increasing dip of about 73 degrees easterly average; strike nearly N.S. (Plan 2, section 3.)

These schists directly abut upon a coarse porphyroid granite. (figs. 1 and 2.) The component, whitish or red felspar, is greatly in excess of the white or smoky quartz. Mica is sparingly disseminated through the mass in lamina of medium size, while black tourmaline crystals intermix with the whole. The character of the granite is intrusive, alternating with Mica Slates and Hornblende schists as far as I could trace it—that is about two miles—forming dykes from less than a yard to several hundred feet. To judge by a shrub, *Melaleuca uncinata*, I only observed growing on granite soils, the granite extends to within about two miles of Maitland, *i.e.*, about ten miles E.W., but is hidden by the surface clay and travertine. Two miles south of Muloowurtie Point, at Hart's Mine, it forms the foot of the Coast Cliff, consisting there almost of pure red felspar.

The following synopsis of the rocks observed represents my idea of their succession in time:—

| | |
|---|---|
| Newer Tertiary | 1. Surface deposits.<br>2. Limestone concretions (on lower levels).<br>3. Travertine (on higher levels).<br>4. Clays and Gravels. |
| Older Tertiary | 5. Ardrossan Clays and Sands.<br>6. Turritella Grits.<br>7. Muloowurtie Clays. |
| Lower Silurian | 8. Ardrossan Sandstone.<br>9. Parara Limestone (fossiliferous).<br>10. White and yellow unfossiliferous silicious limestone. |

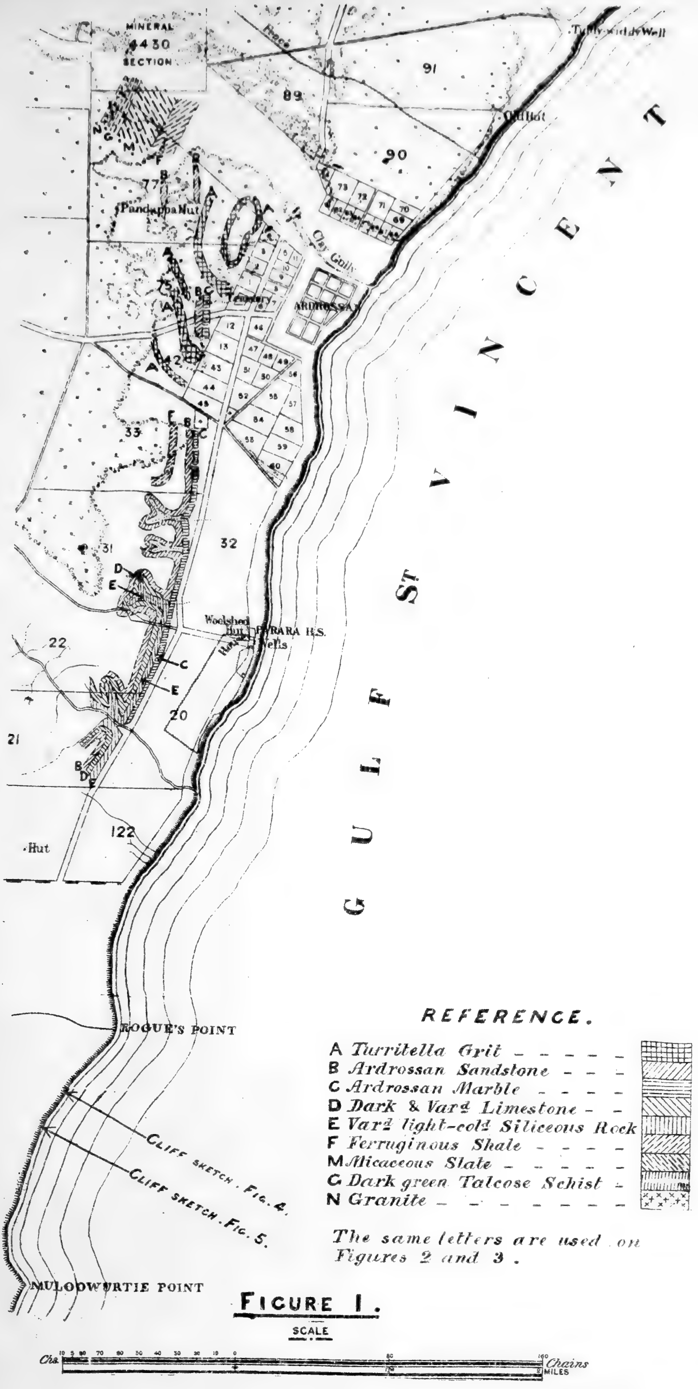



FIGURE I.

SURVEYOR GENERAL'S OFFICE, ADELAIDE. *Frazer S. Crawford, Photo-lithographer.* (8.373)

Plate 2.

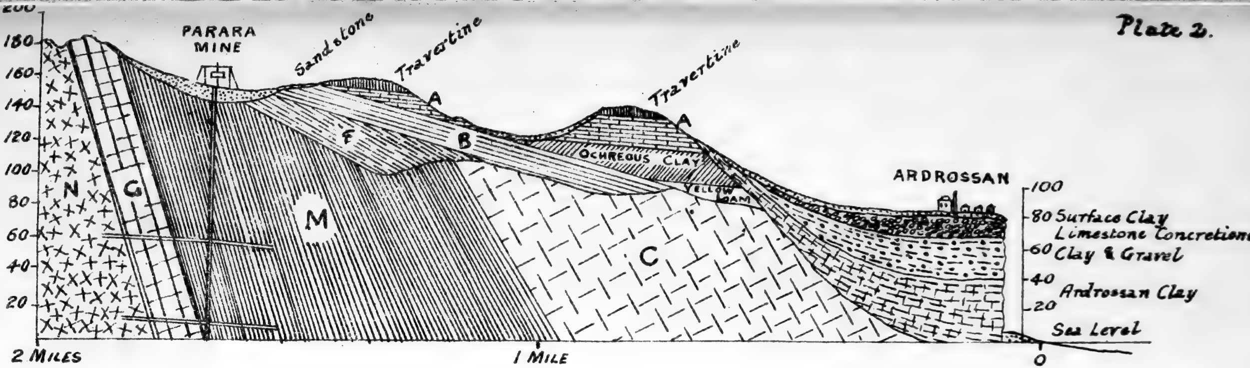



FIG. 2.

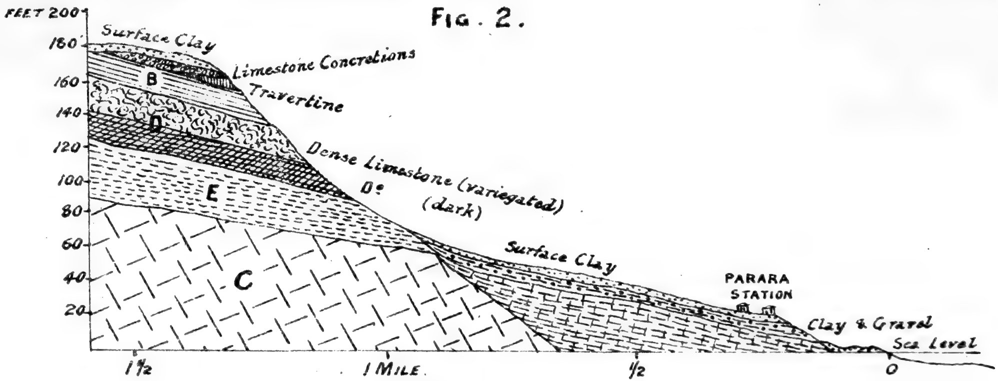



FIG. 3.

SURVEYOR GENERAL'S OFFICE ADELAIDE. *Frazer S. Crawford, Photo-lithographer.*

Plate 3.

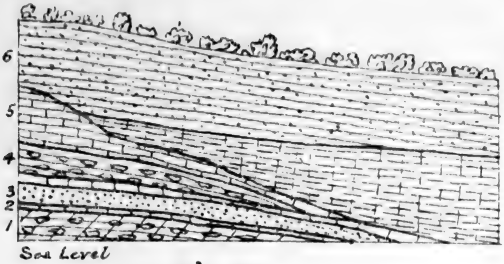



Fig. 4.

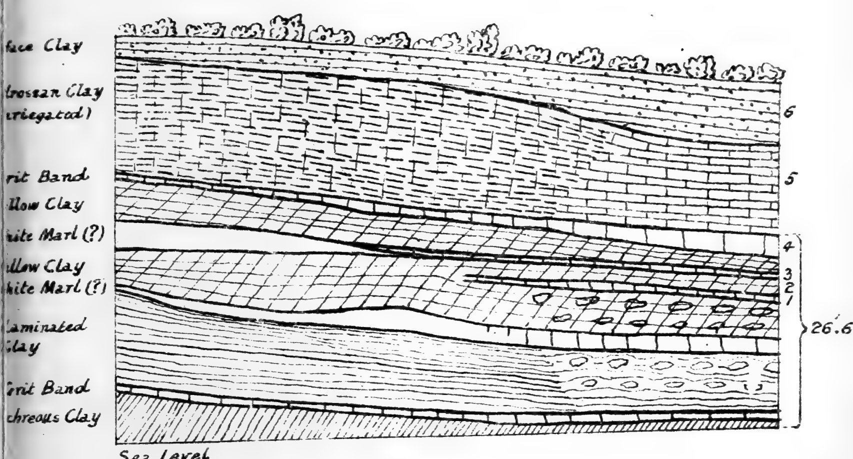



Fig. 5.

SURVEYOR GENERAL'S OFFICE, ADELAIDE. Frazer S. Crawford, Photo-lithographer.

| | |
|---|---|
| Pre-Silurian | 11. Ardrossan Marbles.<br>12. Micaceous Slates.<br>13. Talcose, Chloritic, and Hornblendic Schists. |
| Plutonic | 14. Granite. |

NOTE.—The Ferruginous Shales represented in fig. 2 as overlying the "Micaceous Slates," have since been ascertained to be decomposed portions of them.

# Note on the Artificial Production of Crystallised Atacamite.

By T. C. Cloud, Assoc. Roy. Sch. Mines, F.C.S., &c.

[Communicated by the President.]

It is well known to chemists that the hydrous oxychloride of copper is produced when oxide of copper is acted upon under favourable conditions by certain soluble chlorides, notably those of ammonia and sodium, but hitherto the attempt to obtain this substance in the form of definite crystals has not been successful. I have, however, to record the conditions under which I have found this substance produced. At the Wallaroo Smelting Works there are large underground culverts connecting the various smelting furnaces with the stack. From certain of these furnaces a substance is produced which deposits in the culvert. This culvert-deposit consists almost entirely of cupric oxide, with a small proportion of an hydrous cupric sulphate. At one part of the culvert there is a small, but constant infiltration of seawater, which in contact with the culvert-deposit above described, and under the influence of the high temperature necessarily existing in such a culvert, has in the course of not more than twelve months produced the hydrous oxychloride of copper in a crystalline condition.

The crystals were found between separated layers of the culvert-deposit, which at this point of the culvert was almost entirely converted into a massive hydrous oxychloride of copper. The crystals were not large, the largest being about one-twentieth of an inch in diameter. An examination of these under the microscope showed that the crystalline form was a combination of rhombic, prism, pyramid, pinacoid, and domes; in fact, the exact form of Atacamite.

The colour was rather lighter than most specimens of the natural mineral that I have met with. A chemical examination was not made, as it was found practically impossible to obtain a sufficient quantity of the crystals free from the massive deposit upon which they were formed, and as this portion contained a quantity of more or less unaltered deposit, its presence in the sample taken for analysis would have vitiated the result.

Having due regard, however, to the conditions under which this substance was formed, and also to its appearance and crystalline character, I think I am justified in stating that we have here an instance of the artificial formation of crystallised Atacamite.

# The Aborigines of South Australia.

By J. D. Woods.

[Communicated by the President.]

Nearly three hundred and forty years have passed away since Portuguese enterprise made known to the world the existence of the Australian continent. More than 100 years ago Captain Cook took possession of New Holland in the name of King George III. An immense number of natives with their possessions came under British rule. But while the country has expanded into a number of States which occupy a splendid position in the family of nations, the native races have in a great measure passed out of existence, and their history can only be traced with difficulty through the scattered and imperfect records which private persons have left behind them. The mode in which the first Australian settlement was commenced and carried on for years was not favorable to any scientific consideration of the Australian savage as a portion of the human family. His occupation of the soil was more an accident than a part of a grand providential design. His land was handed over to men who could show no claim to it except that which rests on the right of the strong. The blackfellow came before long to be looked upon as an interloper, one who had no right even on the soil, and his life was held of little more account than that of the kangaroo, which constituted a chief part of his daily food. A learned Judge in Tasmania in the early days formally decided that the lessee of a sheeprun could prevent aboriginal natives from "trespassing" on the land included in the lease. Botany Bay, where Cook first put foot on shore, was inhabited by a large native population. They offered no serious resistance to his landing, but those who were present at that time showed at least that they did not hail the new arrivals with much satisfaction. The actual occupation of New Holland by the English did not take place for many years afterwards. Captain Phillip, R.N., who founded the first settlement in 1788, was met by a large number of aborigines, who at first made a slight demonstration against the new comers, but their weapons were soon laid aside, and they became friendly with the intruders. This is the substance of the accounts of the Australian natives who first came into contact with the white men.

The physical characteristics of the natives who inhabited the eastern shores of Australia in those days, as far as any note was taken of them, appeared to be in all respects similar to those of the tribes who have occupied the coast line in other parts of the continent. The men were tall and well formed. They had broad foreheads, wide mouths, small piercing eyes, flattened noses, and thick black hair. Their chests were deep, but their lower limbs thin and ill-developed as compared with those of average Europeans. They were remarkable for the beauty and strength of their teeth, for the boldness of their carriage, and for the comparative smallness of their hands and feet. Although perfectly black, they were different in appearance from the natives of Africa, wanting the woolly hair and the great thickness of lips for which the latter are remarkable. The women were smaller than the men: in appearance worse looking, and with frames not so well developed. The aborigines all round the Australian coastline bear the same description, and are supposed to have sprung from one source.

This supposition is to a great extent confirmed by a general uniformity of customs, a similar uniformity in the laws which govern the relationships of individuals to members of their own tribes, and to those of the tribes to which their parents belong, and also by the uniformity in those laws which apply to the possession and occupation of territory. Their weapons are generally similar, everywhere consisting of spears, shields, boomerangs, wooden axes and waddies, or clubs. The Botany Bay natives had bows and arrows. These are uncommon. In some portions of Australia the spears are pointed with flint or stone heads and barbs, and the natives in some places use flint knives and stone hatchets or tomahawks, the heads of which are fixed into cleft sticks, and secured with a rude kind of cord firmly kept together by some resinous substance. On the seashore canoes made of bark are commonly used for fishing, but only where the indigenous trees are large and abundant, and access to the beach is easy.

The languages, or rather the dialects, which are or were in use in those portions of the country which have been opened out by the progress of settlement afford strong presumptive evidence of a common origin. Although far from complete they are sufficiently numerous to furnish satisfactory basis of comparison, which have led those who have investigated the question to the belief that they are no more than modifications of one form of speech which some peculiar customs have called into existence. One of these is the practice of never uttering the names of dead persons. Now as the names of the natives are mostly the names of some natural features of the places in which the bearers are born or after some creature or special occurrence, the death of a person necessitates a change in the name of these also, and the new names in time become fixed terms in the language, instead of serving as a temporary expedient. The effect of this when in operation amongst hundreds of distinct tribes can easily be imagined. The marriage ceremonies vary to some extent amongst different tribes. In some cases the wives are stolen from other tribes, in others they are sold or given away. In nearly all cases they are promised or disposed of whilst still children or even infants, and the promise is almost universally rigidly performed. If the first husband should die the woman belongs to his heir—that is, a brother succeeds to the wives and offspring of his deceased brother if they both bear the same family name. On this some remarks will be made further on. The stealing of a wife is always avenged as an act of warlike aggression. Where the laws relating to marriage are carried out with some degree of strictness, it might be supposed that the chastity of the females would be respected and preserved. This is far from being the case all through the continent. On the Northern coast it is most rigorously enforced, but in the Central and Southern portions such a thing is not thought of. In fact the orgies which the tribes carry on amongst themselves and amongst other tribes which meet them on friendly terms will not bear description. Mr. Eyre, who was Protector of Aborigines at Moorundie in 1841, treats of this subject at some length. His knowledge of this branch of the social state of the natives could only be recorded in a Latin footnote; but bad as that was, it pales utterly before the horrors continually practised on young females amongst the tribes which occupy the country about the Peake, Tennant's Creek, Alice Springs, the Charlotte Waters, and amongst the Dieyerie tribe. A more fitting opportunity than the present will be taken to record the details of those facts which have been communicated to the writer by trustworthy authorities, and which are as singular as indeed they are revolting. The marriage bond is not considered permanent, a husband bartering away or selling his wife (mostly an old one) whenever by any means he can obtain another. Of course it will be seen from this that polygamy is universal; indeed there is no tribe of which there is any account where it does not obtain; but the wife runs the risk of losing her life if she leaves her husband, and she is recaptured by him or by the tribe.

The funeral customs which prevail amongst different tribes are by no means uniform. In Western Australia the corpse is buried in a grave laid out due east and west, and the face of the dead person is turned to the east. The grave first, however, is purified from the presence of the sorcerer who caused the death, by having a quantity of branches burned in it. The bottom is strewn with leaves, on which the body is deposited. It is then covered with branches secured by cross sticks, and finally filled with earth. Whilst the burning is in progress an old man of the tribe attentively watches the grave to see in which direction the exorcised sorcerer travels, for that is supposed to lead to the detection of the murderer. Amongst the Adelaide tribe a sort of inquest was held, and the body buried without the formalities above noted; but the position of the grave east and west was preserved, and a small fire at the head of the grave was supposed to keep evil spirits away. Amongst the Murray tribes and those belonging to the country around Encounter Bay the corpse was smoked until dried, and then deposited on a platform in a tree out of the reach of wild dogs. The Central Australian tribes eat their dead to prevent the survivors sorrowing for them. The body is taken to the grave, and amongst the Dieyerie, at least, a sort of inquest is held to discover who killed the deceased, after which the flesh is cut from the muscular parts of the body and distributed amongst the tribe to be eaten. There are certain rules by which this shocking practice is regulated. Fathers do not eat their children, but the mothers do. Other relatives eat each other indiscriminately, except that sons do not eat their parents' flesh, &c. The other tribes in the Interior of which the writer has any accounts are all addicted to the same cannibal customs. All deaths are looked upon as the result of witchcraft, and are avenged accordingly on some member of another tribe. When a child dies the mother eats the head, and the children in the camp are fed with the foul diet to cause them to grow. When grown persons die those who eat the corpse take those portions wherein they think the deceased person's abilities or distinguishing characteristics are supposed to have been located. Infanticide has prevailed all over the continent for the sole purpose, it seems, of leaving the wife free to attend upon the husband who for the time may happen to own her. The practice of polygamy and of infanticide, as well as the prevalence of other customs which cannot be mentioned here, have contributed greatly to keep the tribes from increasing to any great extent. To those who know what these have been in former times, and what they are now, where the tribes are numerous, it is a matter of wonder that they have continued to exist so long as they have done. Amongst all the tribes wherever they have been found there are special rites and ceremonies which must be undergone by youths before they can be considered to be men. The old men are in all cases most watchful on such occasions lest their proceedings should be witnessed by strangers, but no woman is suffered on pain of death to see what is done, or to come near the spot where the strange performance takes place. In some localities the rite of circumcision is all that is necessary. This is the case amongst the tribes near and beyond the Peake. Amongst other tribes, as in Western Australia and the southern part of this colony, the youth is inducted into manhood by many stages, the last of which is not reached until late in life. In some parts of the continent circumcision is not practised, but the tribes that omit this custom are not very numerous. The tribes living about Alice Springs, Charlotte Waters, and in the adjacent portions of the country have customs by which young females become women and are permitted to marry. The treatment they undergo on these occasions has doubtless a powerful influence in checking a rapid multiplication of the scions of the tribes, and from its nature must not unfrequently end in the deaths of some of those who are subjected to it. In a paper like this it is impossible to enter into the particulars of many of the customs, which plainly show how low in the scale of humanity the Australian savage stands. At the same time they cannot be altogether ignored. Without pursuing the subject further on this occasion it may suffice to say that the inner life of some of the Australian tribes is made up of the most barbarous cruelties and the most loathsome obscenities that can be conceived even of a savage people. In spite of this the children that are permitted to survive are treated with the greatest kindness and affection. They are well fed and carefully instructed in all those essentials which can fit them to become useful and productive members of the community of which they form a part. This all ceases when they reach the adult stage of life. The male becomes then subject to all the laws and disabilities of the tribe, and the female is the slave of him who takes, buys, or steals her in marriage. He has the power of life and death over her, and this is not used with a sparing hand.

The *corroborie*, as it is called in New South Wales, has the same characteristics throughout Australia. At times it partakes of a festal character; at others it forms sort of a warlike demonstration. One phase of it is too disgusting for description. The festal gatherings amongst strange tribes very often end in fights. These corrobories are mostly held at or near the full moon, and they form a strange and interesting sight when the natives are numerous and peaceably inclined towards each other. The Peake and Charlotte Waters tribes are divided into four classes of families or subtribes, called the Parulà, the Pooningà, Pultarà, and Coomarà. A Parulà can only marry a Pooningà, and their children only become Pultarà or Coomarà. If the Parulà is the father, the children are Coomarà; but if the mother, the offspring are Pultarà. A Pultarà may only marry a Coomarà. If male the children are Pooningà, if female Parulà. Similar rules prevail in Western Australia, in Queensland amongst the southern tribes, and amongst the Dieyerie; no doubt they exist elsewhere. The custom reduced to simple terms is that children of either sex always take their mother's family name, and a man cannot marry a woman of his own family name. Sir George Grey, in dwelling on this circumstance, notices in it a coincidence with customs which prevail amongst the North American Indians. It is stated in Mr. Taplin's work (on the authority of the Rev. Mr. Tison) that it exists amongst the Tamil and Telugu population of Southern India, as well as amongst the natives of Fiji and the Friendly Islands. How it came to Australia is one of those mysteries which probably will never be cleared up.

The natives in general have no notion of accumulating property except as far as relates to their weapons for hunting and war, and those few articles made by the women in their rude domestic economy. In the Interior, however, a sort of trade is carried on amongst distant tribes. In the North one association of tribes supplies another at a distance with shields and other arlicles through the agency of an intermediate tribe, receiving at their hands supplies of red ochre, which is used in some of their ceremonies, but which is not to be found in the country in which the shields are made. The Dieyerie tribe have a sort of trade among themselves, but it seems to begin and end with a love of novelty without leading to accumulation. It has already been pointed out that wives are frequently bought and sold. Some of the tribes that have been met with in the Interior have shown themselves to be peaceable and friendly to white men. Such natives were met with by Bourke and Wills, and some by the Overland Telegraph Construction party, and to a friendly tribe the safety of Colonel Warburton's party was due. As a rule, however, they are hostile to all strangers, cruel, and treacherous. They are, moreover, accomplished thieves, taking by stealth or stratagem any of the coveted articles commonly seen in the hands of white men, when they cannot obtain them by murdering the possessors. From the testimony of writers who had a knowledge of the natives of Australia in New South Wales before the foundation of this province, it seems clear that individual natives actually possessed property in the land on which they lived, as distinct from that of the tribe. The same fact existed in Western Australia, and it was officially stated to exist in South Australia. The evidence is to be found in the second report of a Select Committee of the House of Commons on South Australia. Certain it is that in all cases the intrusion of one tribe into the territory of another without leave or invitation is regarded as an act of war, and is resented accordingly. If this intertribal custom in connection with the fact of ownership, personal and tribal, could have been impressed upon or had been recognised by those who controlled the process of settlement in the Australian colonies when they were founded it is not improbable that the natives would not have disappeared as fast as they have done. The recognition of the rights of a tribe or of an individual must have entailed some official attempt to preserve the language, in order to make the record of sale or transfer complete, and this again must have brought with it a careful observation of manners and customs, which in a scientific point of view would have been of the greatest value at the present time. The rights of the natives, although enforced against each other, were not enforced against the Europeans, and the result is now before us in the absolute extinction of those tribes who were first associated with Europeans, and the total loss of their language. Amongst existing tribes, and those whose histories have been recorded, there seems to be one system of law which applies to offences of a grave character. Murder is invariably punished with death. There is no known deviation from this rule. Adultery, strange to say, is similarly punished unless it should occur with the consent or connivance of the husband. The intermarriage of individuals of the same family is looked upon as incestuous, and is avenged by death. Amongst the natives at Alice Springs and the surrounding country the punishment inflicted on the offending woman is horrible. She is mutilated with stone knives, and in one instance narrated in a letter in the writer's possession the unfortunate delinquent was so cut about that her bowels came out through her back. The natives, however, do worse than this, and such treatment may be regarded as merciful in comparison with some of the punishments they inflict on such occasions. If a native has killed another his life is forfeited to the tribe of the deceased. If he should die or succeed in eluding the vengeance of those who seek his life his brother or some other relation must suffer in his place. For trifling offences the guilty person submits to have a spear thrust through his leg or arm, an infliction which is held to wipe out all but capital crimes. At this point I must close. Other peculiarities of the Australian savage, relating to his superstitions, his mode of procuring his food, of cooking it, and of the laws which fix its consumption, and its manufacture, would occupy too much of the time of the Society for one evening. On a future occasion I hope to supplement this paper by another and place before the Society some particulars relating to tribes only recently met with in

Northern Australia and Queensland. In the meantime the writer begs indulgent consideration for the imperfections which are manifest in this paper. The communications which were expected from the quarters above mentioned did not come to hand as expected. The preparation of this paper was consequently postponed from time to time, and was eventually completed in some haste.

# A List of Australian Starfishes.

By the Rev J. E. Tenison Woods, F.G.S., F.L.S.,
President of the Linnean Soc., N.S.W., Hon. Member of the Adelaide Phil. Soc., &c., &c.

A list of Australian Starfishes has long been a desideratum amongst naturalists. It has been rather difficult to obtain, because of the scattered way in which the various species peculiar to our coasts have been described. The British Museum Catalogue of Gray is very imperfect, and the same may be said of Müller & Troschel's System der Asteriden (Braunshweig, 4to., 1842, with twelve copper plates.) Agassiz's Memories on the subject have never been completed, and at the present day there is no good general work on Starfishes. Quite recently (1878), M. Edmond Perrier, Professor of Zoology (Mollusca and Zoophytes) at the Museum of Natural History in Paris since 1876, has published a very interesting memoir on the geographical distribution of Starfishes (Nouvilles Archives du Museum, 2nd series, vol. 1, p. 1.) The nature of the essay does not permit of any definition of species or genera, but he gives lists of names which will be found very useful to the inquirer. It is pleasing to observe also that he makes flattering mention of the work of Captain Hutton, of New Zealand, the only naturalist who has dealt with the subject in Australasia. In dividing the Pacific region into four provinces Professor Perrier makes the Australian region one and gives us credit for 46 species. I am enabled to increase the number to some extent in the list which I subjoin, but I am fully aware how imperfect it must be since more than 70 have been determined by me in the various Australian collections, public and private, and from specimens found by myself. It will be seen also that I am able to afford information as to the habitat of a very few of the species named, but I propose to follow this brief paper with a much more detailed one, in which I shall furnish bibliographical references. I venture, however, to hope that this very brief enumeration will give some help to students and naturalists who may desire to deal with the subject. I shall be very glad to receive further communications from any one on the subject, who may know of Australian species not enumerated here, so as to make my future list as complete as possible.

### Family Asteriadæ.

#### Genus—Asterias, *Linné*, 82 species.

1. A. calamaria, *Gray*.
   Common in Port Jackson, Twofold Bay, and probably on all the South-East coast of Australia. Tasmania; also in the Mauritius and New Zealand.
2. A. fungifera, *E. Perrier*.
3. A. globifera, *Gray*.
   Tasmania.
4. A. granifera, *Lamarck*.
   Australia.
   With five subterete rays, reticulately granular, longer granules, shot-like. The back is covered with a network of round grains, with granular, smooth-like points, some small, some large, with a small pedicel.
5. A. polyplax, *Muller* and *Troschel*.
   Tasmania.
6. A. sinusoidea, *E. Perrier*.
   Storm Bay, Tasmania.
7. A. tenuispina, *Lamarck*.
   This is a Mediterranean species, and its occurrence in Australia is doubtful. Von Martens is the authority. It has, however, a very wide range, and occurs in Mauritius.

#### Genus Calvasterias, *Perrier*.

8. C. asterinoides, *E. Perrier*.
   Cape Grenville, Torres Straits, North Australia.

### Family Echinasteridæ.

#### Genus Solaster, *Forbes*, 8 species.

9. S. decanus, *Muller* and *Troschel*.
   S. W. Australia.

### Family Linckiadæ.

#### Genus Nectria, 2 species.

10. N. ocellifera, *Lamarck*.
    It may help to its identification to give its diagnosis. Unarmed, pentagonal angles extended, corniculate; back convex, tesselated with rounded granular, nearly spherical plates.

### Family Goniasteridæ.

#### Genus Anthenea, *Gray*, 7 species.

11. A. acuta, *E. Perrier*.
12. A. tuberculosa, *Gray*.
    Port Essington.

### Genus Culcita, *Gray*, 8 species.

13. C. pentangularis, *Gray*.
N. E. Australia. Chevert expedition. West Australia *(Gray)*.

14. C. Novæ Guineæ, *Muller* and *Troschel*.
N. E. Australia. Chevert Expedition.

### Genus Goniodiscus, *Muller* and *Troschel*, 9 species.

15. G. seriatus, *Muller* and *Troschel*..
South-West Australia.

### Genus Pentaceros, *Linck*, 31 species.

16. P. australis, *Lütken*.

17. P. Franklinii, *Gray*.

18. P. gracilis, *Lütken*.
East Australia.

19. P. granulosus, *Gray*.
West Australia.

20. P. nodulosus, *E. Perrier*.

21. P. valvulatus, *Muller* and *Troschel*.
South-West Australia.

22. P. turritus, *Linck*.
N.E. coast, Cape Grenville; Port Essington *(Tate)*.

### Genus Pentagonaster, *Linck*, 94 species.

23. P. paxillosus, *Gray*.
Port Essington.

24. P. inæqualis, *Gray*.
Endeavour River.

25. P. spinulosus, *Gray*.
Port Denison, Cleveland Bay.

26. P. (Dorigana) Dubeni, *Gray*.
West Australia. South Australia *(Tate.)*

27. P. (Dorigona) Gunnii, *E. Perrier*,
Who gives the locality George Town, Australia, probably meaning George Town at Port Dalyrmple, Tasmania. The species is found on the Victorian coasts also.

28. P. (Dorigona) pulchellus.
New South Wales coast, Tasmania, and New Zealand.

29. P. (Stellaster) Belcheri, *Gray*.
North-East Australia, New Guinea.

30. P. (Stellaster) Childreni, *Gray*.
Port Darwin, Cape Cleveland.

31. P. (Stellaster) granulosus, *E. Perrier*.
New South Wales.

32. P. (Stellaster) Incei, *Gray*.
South Australia, King's Island, Cape York.

33. P. (Tosia) astrologorum, *Muller* and *Troschel.*
34. P. (Tosia) auratus, *Gray.*
35. P. (Tosia) australis, *Gray.*
West Australia. South Australia and Tasmania *(Tate)*.
36. P. (Tosia) grandis.
West Australia.
37. P. (Tosia) magnificus, *Muller* and *Troschel.*
Tasmania and Bass' Straits. Apollo Bay?
38. P. (Tosia) nobilis, *Muller* and *Troschel.*
Manly Beach, New South Wales? South-West Australia.
39. P. (Tosia) ornatus, *Muller* and *Troschel.*
Port Stephens or Moreton Bay?
40. P. (Tosia) ruber, *Gray.*
South Coast?
41. P. (Tosia) tubercularis, *Gray.*
Swan River and Champion River, West Australia.

## Family Asterinidæ.

### Genus Asterina, *Nardo*, 28 species.

42. A. calcar, *Lamanarck.*
This species is very common all along the south coast, and in N. S. Wales as far as Port Jackson. Tasmania?
43. A. exigua, *Lamarck.*
The same localities, and extending into Tropical Australia. It is also found at the Cape of Good Hope, Java, the Mollucas. Very small; pentagonal, convex, with very minute pores; concave papillose below.
44. A. Gunnii, *Gray.*
All the south coast and Tasmania.
45. A. regularis, *Verrill.*
Australia, and in New Zealand.

### Genus Patricia, *Gray*, 2 species.

46. P. crassa, *Gray.*
West Australia.
47. P. ocellifera, *Gray.*
West Australia.

## Family Astropectenidæ.

### Genus Astropecten, *Linck*, 62 species.

48. A. polyacanthus, *Muller* and *Troschel.*
Very common in Port Jackson.
49. A. triseriatus, *Philippi.*
South-West Australia.
50. A. Pressii, *Muller* and *Troschel.*
West Australia; South-West Australia *(M. and T.)*

51. A. VAPPA, *Muller* and *Troschel.*
South-West Australia *(M.* and *T.)*. Port Jackson. I am not certain of this identification; it may be an undescribed species.

GENUS ARCHASTER, *Muller* and *Troschel*, 9 species.

52. A. ANGULATUS, *Muller* and *Troschel.*
Port Darwin. Torres Straits.

53. A. TYPICUS, *Muller* and *Troschel.*
Cape Grenville, Endeavour River, Port Darwin.

# The Natural History of the Country around the Head of the Great Australian Bight.

By Professor Ralph Tate, Assoc. Lin. Soc., F.G.S.., Corr. Memb. Roy. Soc. Tasmania, Acad. Sc. Philadelphia, &c., &c., President.

Contents:



## Natural Divisions of the Country around the Head of the Bight.

The western portion of the country which lies around the Head of the Great Australian Bight is almost a *terra incognita* to the naturalist, though its topography is fairly known. Because of its unique structure, and co-ordinate peculiarities in its fauna and flora, it claims our chief interest. The eastern portion is not devoid of interest, but it lacks the novelty of isolation and inhospitality; its leading characters are those of the whole region extending to Spencer's Gulf. In this paper I confine myself almost exclusively to the western portion, to which I have given the name of the Bunda Plateau, but incidental references are made to the other.

## Boundaries of the Bunda Plateau.

They are on the south, the line of perpendicular sea-cliffs which stretch in an unbroken and inaccessible wall, commencing at three miles west from the Head of the Great Australian Bight to the headland called Wilson's Bluff, on the frontier of West Australia, and having a frontage of a straight line of

Plate 4.


Fig. 2.

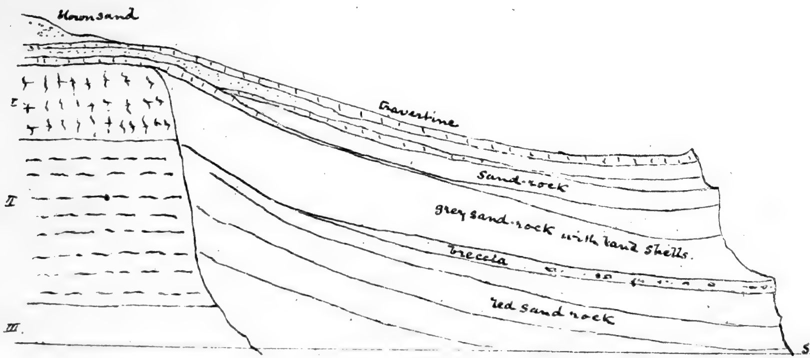
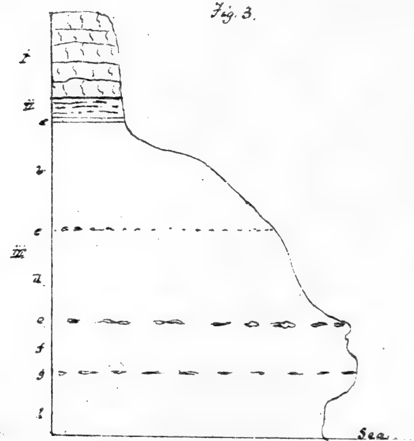



Fig. 3.




SURVEYOR GENERAL'S OFFICE, ADELAIDE. Frazer S. Crawford, Photo-lithographer.

R Tate, delt

127 miles. Its western boundary is the line of scarped cliffs trending in a north-west direction from Wilson's Bluff; on the east by the edge of higher and undulating ground following an irregular, but generally north-east line from the Head of the Bight to a few miles west from Pidinga, lat. 30 deg. 10 min. 25 secs., long. 132 deg. 7 min. 1 sec., continuing thence, probably, to Ooldea Water in lat. 30 deg. 20 min., long. 131 deg. 50 min. 31 secs. Its northern boundary is not known, but is probably south of a line curving from Ooldea Water to Boundary Dam, a few miles to the west of the meridian of Eucla, and in lat. 29 deg. 20 min.

The same geological features prevail throughout this region, but differ from those of the country bordering it. Its other natural features differ in different parts, though a general uniformity prevails throughout.

I have adopted the name *Bunda* for the Plateau, that being the native term for the sea-cliffs; a portion of the Plateau is known as the Nullarbór Plain.

## Previous Explorations.

The Bunda Plateau is memorable in the annals of South Australian geographical research, by the privations which one of the bravest of her explorers, Edward John Eyre, suffered in traversing it. It has since then been crossed in an east and west direction and skirted by several travellers; and now since the erection of water-tanks at distances of about forty miles, rendered necessary by the work of maintaining the telegraph line in good order, a journey from the Head of the Bight to Eucla presents no difficulty.

Flinders.—The seaboard of the Bunda Plateau was surveyed from the sea by Flinders in 1802, and the appearance of its cliffs depicted by drawings and words, he stating that their elevation appeared to be from 400 to 600 feet.

Eyre.—In 1840 he undertook to explore the unknown country lying between this colony and West Australia. Streaky Bay was made the base of operations, and his attempt to round the Head of the Great Australian Bight was a fruitless one. On a second attempt he was driven back upon Fowler's Bay, after penetrating to within twelve miles of the Head of the Bight. From that place he started, January 2, 1841, on a third attempt, and succeeded in reaching the last of the sandhills, which intervene between the Head of the Bight and the commencement of the cliffs, called Bunda by the natives, from whence he penetrated forty-five miles along the cliffs, and then returned to Fowler's Bay. Nothing daunted, he essayed a fourth time, having previously reduced the strength of his party to his overseer Baxter and three blacks. Starting from Fowler's Bay, February

25, 1841, he reached Keer-Kumban-Kauwe* on March 2. Setting off on the 7th, the journey across the Bunda Plateau to the sand-hills at Eucla was accomplished on the 11th, "and thus on the fifth day of our sufferings we were again blessed with an abundance of water." Thus a journey of about 140 miles was accomplished in five days, during which time no water was obtained, and the distress endured by men and animals was extreme.

In 1860 Major Warburton contrived to reach 85 miles beyond the Head of the Bight, and made several journeys from the coast in a north and north-west direction for a distance of about 60 miles. He found the district to the north to be a dreary waste, destitute of food and water. Rain seldom fell, and when it did was immediately absorbed by the arid soil. The above paragraph is quoted from "Forrest's Explorations," p. 77, but I do not know the source of his information.

Captain Delisser was employed in 1865-6 by this Government to survey certain lines within the district. His observations are affixed to the "Plan showing Surveys and Explorations by Mr. E. A. Delisser in the vicinity of the Great Bight and Fowler's Bay," published by the Survey Office in August, 1867. One line of traverse was from the Head of the Bight to 100 miles north from Eucla.

On the discovery of the roadstead off Eucla, Lieut. Douglas, President of the Marine Board, was entrusted with the duty of its survey. He, moreover, fixed the boundary line between the two colonies, which resulted in placing Eucla some five miles within West Australian territory, and Wilson's Bluff, the western termination of the Bunda Cliffs, less than one mile east of the 129th meridian—the boundary line.

In 1870 Mr. John Forrest headed an exploring party, which succeeded in traversing from Perth to Adelaide, around the Head of the Great Bight, nearly retracing the route of Eyre. From Eucla he made a flying trip northward, on the track of Delisser, but was unable to penetrate more than 27 miles, because of the absence of water. The country is described by him as open plains of grass, and that from the camp only plains were in sight; not a tree visible. He thus reiterates the observations of Delisser, which, however, extended many miles further. On the 14th of July Forrest's expedition started, carrying about thirty gallons of water. "After great privation," he writes, "to our horses, and not meeting with a drop of water for 135 miles, by travelling day and night we reached the Head of the Bight on the evening of the 17th." His route for the first 60 miles pretty nearly coincides with the telegraph line; thence he steered south of east and to the

*Written Coymbra in modern maps.

coast, which he followed to the Peelunibie sand patch at the Head of the Bight, where water was procured by digging in the sand.

His observations are the most meagre, but he describes the country as generally level, open, and grassy, and entirely destitute of water. He perpetuates, moreover, the error of Flinders respecting the height of Bunda Cliffs, and overlooks the partial correction given by Eyre.

Cornish surveyed a north and south line on the meridian of Ooldea Water, which passes through for many miles the eastern portion of the Bunda Plateau. His observations on the country have not been published.

Mr. Muir has lately travelled sheep from the Head of the Bight to Eucla, following pretty nearly the course of Delisser's surveyed line; but his actual route was determined by the position of the few rock holes which occur on either side, though not distant more than a few miles.

This region may be said to have been much travelled during the construction of the telegraph line, which traverses the Plateau at an average distance of ten miles from the coast, and follows Delisser's chief east-and-west line to within 45 miles from Eucla. By a fortunate circumstance it passes through the very best country.

In the latter part of 1878 Messrs. Fairlie and Woolley and a black started from Eucla in a N.N.E. direction in search of sheep country. The party not returning within a specified time, and one of their horses having come back, their Eucla friends, anxious for their safety, dispatched Messrs. Muir and Clark in search of them, who found Mr. Fairlie's dray at 80 miles out, but lack of water necessitated their return. However, a search party with camels was immediately sent out, and though the lost men were tracked to 100 miles out, and back to within three miles of their dray, neither men nor horses were found. No doubt of their sad fate is to be entertained, as the country has been graphically described to me by more than one of the searching parties, and briefly as a level stony desert, without water and trees, and the scantiest of vegetation. I exhibit to you memorials of this journey in the form of three species of fossils obtained at the last camp of the ill-fated explorers. They conclusively prove that the stony surface in this distant place is of the same nature as that of the top of the Bunda Cliffs.

Lastly, I was employed by the Government to examine the Bunda Plateau, with the view of forming an opinion as to the applicability of the artesian principle to obtain water. I was accompanied by Mr. Barron, trigonometrical surveyor, and John London, as general assistant, proceeding to Fowler's

Bay, which was reached on January 18th, 1879. Here the party was fully equipped, Richard Dorey joining to take charge of the seven camels which were our sole means of transport.

The route travelled is briefly sketched as follows :—

A start was made on the 24th, passing by Colona, Waltabie, to the sea coast at Coymbra, and reaching the Head of the Bight on the 30th.

On the 31st left Head of Bight, watering at Peelunibie, thence on to telegraph line as far as a deep well known as Roberts's, camping near two caverns at two miles north-west from the well.

Feb 1st.—Along telegraph line to Mallabie tank and rock hole, passing two other silent witnesses of the futile efforts to obtain water by deep wells.

Feb. 2nd and 3rd.—Travelled due north-west 33 miles from Mallabie.

Feb. 4th to 7th.—Thence to Eucla, with but slight deviations from a right line.

Feb. 8th.—Excursion along the escarpment of the Bunda Cliffs to the Mundundarra sand patch fifteen miles from Eucla.

Feb. 10th.—Excursion to Wilson's Bluff, eight miles from Eucla.

Feb. 11th to 16th.—Travelled along edge of Bunda Cliffs to 90 miles from Wilson's Bluff, thence inland to Mallabie tank.

Feb. 17th and 18th.—From Mallabie to termination of the Bunda Cliffs, thence round western edge of the Peelunibie sand patch to the Bight sheep station.

Feb. 19th.—Excursion around the shore of the Head of the Bight to the sand-rock cliffs on its western side.

Feb. 20th to 23rd.—To Pidinga rock basin, excavated in metamorphic rocks, flanking on the east a granitic boss ; bears about north-west from the Head of the Bight, distant 72 miles.

Feb. 25 to 27.—Pidinga to Colona, inspecting five wells recently sunk by the Government, and thence to Yalata, Fowler's Bay.

At this date so little time remained at my disposal, that not only was further exploration impossible, but all expedition had to be used to enable me to reach Adelaide on March 11th, but in spite of our most strenuous efforts the metropolis was not regained till the 17th.

The interval between our first departure from and return to Yalata, Fowler's Bay, was 34 days, during which time our camels had accomplished a journey of 566 miles in 29 travelling days, or an average of 19·5 miles per day.

My experiences of camels and camel-riding are not of a pleasant nature, and the physical and mental relief on gaining Yalata, where the camels were dispensed with, was of the most refreshening kind. From that place a ride of 200 miles on horseback brought us to Streaky Bay, but the journey was broken for a day at Pinong to permit me to visit Lake MacDonnell. From Streaky Bay the rest of the overland journey was done in a mail car; Port Lincoln was reached on March 14th, and there ended my travels by land of about 1,000 miles occupying seven weeks.

The length of time occupied in each day's journey, and the mode of travel, rendered collecting an almost impossible task; the opportunities for doing so were after each day's travel, when usually less than an hour of daylight remained to me, and the few occasions on which a lengthier halt than usual was made. The routine—Up at 4.30 a.m., start at 6, noonday halt for lunch, travel to 3.30 or 4 p.m., whilst dinner and preparing for the night invariably occupied us till after 5 p.m.—was forced on us because of the limited time at my disposal, and the absolute necessity there was of making rapid progress from one watering place to another. Of the 34 days occupied in the survey out from and into Fowler's Bay, only for five days were the camels in camp, but these were not days of enforced idleness for me, as an average of thirteen miles travel per day was done in visiting geological sections.

### Form of the Ground of the Bunda Plateau.

The Bunda cliffs constitute the sea margin of an approximately level plateau, the elevation of which at their eastern termination is 155 feet, but which gradually increases to 250 feet at Wilson's Bluff on the west, rising thence inland to 290 feet at the summit level of the dray road to Eucla. The first 45 miles from the Peelunibie sandhills, the coast cliffs are crowned with loose sand, which forms a raised lip on the margin of the plateau; with the increasing height of the cliffs, the sand becomes less in amount and discontinuous, and is finally seen in dome-like patches, trailing away to the north-west. But for these interruptions, the whole surface along the cliff edge is almost level, showing only a slightly flowing outline. In these particulars I am in accord with Mr. Eyre, who writes "there was no perceptible inclination of the country in any direction, the level land ran to the very borders of the sea, where it abruptly terminated, forming steep and precipitous cliffs" (I. p. 324), and "to the westward we found the country rising as we advanced, and the cliffs becoming higher" (p. 325). The height of the cliffs is stated by Flinders (I. p. 96) "to be nearly the same throughout, being nowhere less by estimation than 400, nor anywhere more than 600 feet." Eyre gives the general elevation at from three to four hundred feet (p. 324.)

My determinations of the height of Wilson's Bluff and the summit of the Eucla Road are from aneroid data compared with the barometric readings taken at the Eucla Telegraph Station. The various heights along the cliff edge were obtained by measure, and are as follows:—

| | | |
|---|---|---|
| East end of Bunda Cliffs ... ... | 145 feet. | |
| 37 miles west from above ... ... | 152 feet, | general level. |
| | 162 " | to crown of sand ridge. |
| 70 miles east from Wilson's Bluff | 200 " | general level. |
| | 235 " | to crown of sand dome. |
| 25 miles east from Wilson's Bluff | 225 feet. | |
| Wilson's Bluff ... | 250 feet (by aneroid). | |

Passing inland from the coast a change of level is perceptible in the form of long synclinal curves and short ridges, but in no determinate direction; and they do not appear to result from undulation of the rocky substratum. For the most part the differences of level between the dips and rises do not exceed ten feet. Where the bed rock is concealed the ridges are crowned with travertine, or travertine rubble, of at least from two to three feet thick; whilst the depressions are occupied with a light loam up to eight and ten feet in depth.

An impression still prevails that the surface of the country declines from the edge of the sea-cliffs, and that the far interior is at or below sea level—a notion that may have been fostered from the fact that not a single watercourse breaks the prevailing uniformity of the surface of the seaward margin of the Plateau. This notion is traceable to Flinders, who, when writing of the Bunda cliffs, says that "the bank may even be a barrier between the interior and the exterior sea, and much do I regret the not having formed an idea of this probability at the time" (I., p. 97). And though Eyre pointed out the incompatability of the existence in the interior of an extensive area of water and the occurrence of excessively hot and dry winds blowing from the same quarter,* yet he has unwittingly given support to the fallacy by a statement made on p. 285, vol. I., and repeated on p. 323, to the effect that the whole of

* "The weather was most intensely hot, a strong wind blowing from the north-east, throwing upon us an oppressive and scorching current of heated air, like the hot blast of a furnace. There was no misunderstanding the nature of the country from which such a wind came. Had anything been wanting to confirm my previous opinion of the arid and desert character of the great mass of the interior of Australia, this wind would have been quite sufficient for that purpose. From those who differ from me in opinion I would ask, Could such a wind be wafted over an inland sea? or could it have passed over the supposed high and perhaps snow-capped mountains of the interior" (I., p. 273).

this level region was completely coated with small freshwater spiral shells of two different kinds. The shells referred to are exclusively terrestrial in habit, and may be found living in the midst of their progenitors.

To illustrate the steady gradient which the land surface presents in a northerly direction, I have constructed a horizontal section from Mallabie to the coast, bearing five degrees west of south-west (true), and in length thirteen miles; also another from the same place bearing true north-west for thirty-three miles. The inland station is thirty-one miles due north from the coast. The aneroid observations between the coast and Mallabie were taken on a journey occupying three and a half hours, and corrected give the elevation of Mallabie at 247 feet above sea level (or 85 feet above sand-lip), or 95 feet above the general level of cliff, corresponding to a rise of seven and four-thirteenths feet per mile; but referred to a datum line striking the coast at its nearest point the grade is ten and five-ninths feet per mile.

The aneroid readings on the traverse north-west from Mallabie are not very reliable, as the barometric disturbances on the second and following days out were very great; nevertheless, they give a gradient in a direct line from the coast of nine feet per mile; the elevation of the interior station being 460 feet above sea level.

Another traverse from the head of the Bight to Pidinga shows much the same surface features, excepting that all the higher parts of the undulating ground are composed of loose sand—being the fringes of the sandy and scrubby rises which bound the Plateau on the east.

The united testimony of those who have penetrated some miles beyond the coast, and applies to the country included within the meridians of Eucla and Ooldea water for a distance of 100 miles, is that the Bunda Plateau is level, treeless, and devoid of stream courses. The opinions touching the aridity of the country are not so unanimous, but the extreme opinions have doubtlessly been formed from observations made at the most and least favourable conditions for vegetable growth. The same explorer would report very differently as to the aspect of the vegetation immediately after copious rains, and after successive seasons of drought, which most observers seem agreed as characteristic of the Bunda Plateau.

In the treeless region the traveller has ever around him an *ignis fatuus* in the form of distant hills clothed with lofty pines. So uniformly level is the surface that his view does not extend beyond a radius of four miles. The hills are, of course, never reached, but the pines dwindle in size as they are approached, and the eye, now no longer deceived by atmospheric refraction, discovers a thicket of broom of about one foot and a half high.

With the exception of the scored face of the escarpment of the Bunda cliffs about Wilson's Bluff, and that around the Pidinga rock basin, the whole region shows no traces of flowing water. Not only is this so for the Bunda Plateau, but is equally true for the whole coast line to near Port Lincoln.

## Geology of the Bunda Plateau.

*Introduction.*—Since the time when Eyre described the Bunda cliffs as being composed for the most part of white chalk with layers of flints, the interest of geologists has ever been active to know if the rock be a true chalk.

Capt. Flinders conjectured "the evidently calcareous nature of the bank" to be the exterior line of some vast *coral* reef, and broached the daring theory that its present elevation arises from the gradual subsiding of the sea, or perhaps from some convulsion of nature.

Eyre confirms the description of Flinders, and gives a detailed and accurate account of the stratification of the cliffs, estimating their height at 300 to 400 feet.

Sturt, in alluding to Flinders' opinion, says:—"The only point we differ upon is as to the probable origin af the great sea-wall. Had Capt. Flinders been able to examine the rock formations he would have found that it was for the most part an oolitic limestone with many shells embedded in it, similar in structure and formation to the fossil beds of the Murray, but differing in colour." All this is a contradiction of Flinders and Eyre, and a misrepresentation of observations made by the latter, who describes the upper surface of the country to consist of a calcareous oolitic limestone, below which is a hard concrete substance of sand and soil mixed with shells and pebbles. Below this again the principal portion of the cliff consisted of a very hard and coarse grey limestone, and below it a gritty chalk.

Eyre is, however, wrong in describing the superficial rock as an oolitic limestone, and Sturt is equally inaccurate in comparing it with the prevailing stone in the Murray cliffs. "Upon what data Captain Sturt made such statements he does not tell us, but it may be here noticed that he thought the beds were continuous with those he observed inland, that is, on the banks of Lake Torrens."—Woods' Geol. Observations in S. A., p. 117.

This guess of Sturt's, which proves to be not far from the truth, seems to have been adopted by subsequent authors, as the Rev. J. E. T. Woods classifies the rocks of this country among the older tertiaries, and Mr. R. Brough Smyth has coloured the area as tertiary in his sketch map of the Geology of Australia. Mr. Woods has more recently sought to bring the fossiliferous formation of the great Australian Bight into closer correlation with the Mount Gambier beds rather than with those of the River Murray.—(Trans. Roy. Soc., N.S.W., 1877.)

A view not accepted by the Rev. W. B. Clarke, who writes—"But somehow the great sections along the Australian Bight have yet to be catechised as to whether the Australian tertiaries follow the laws which rule the existence of these deposits in Europe, or whether the peculiar aberrations noticed by Mr. Woods in some of his valuable writings are or are not exceptions to those laws."—(Sedimentary Formations of N.S.W., 1878, p. 95.)

Aware of the great interest that had thus grown up respecting the cliffs of the Australian Bight, I naturally allowed the desire to scientifically examine them to influence me in undertaking the commission, which seems likely to prove an arduous one, and one not without risk, offered me by the Government. But one of the greatest disappointments which it has been my illfortune to experience as a geologist was in reserve for me, as I travelled along the whole line of the Bunda cliffs without having been able to make a close inspection of them, because with the sole exception of the west face of Wilson's Bluff they are inaccessible. My first acquaintance with the Bunda cliffs was made at Wilson's Bluff, and unaware of their inaccessibility throughout their range I did not repeat my visit, which I otherwise would have done; and as my chief occupation on that occasion was the construction of a stratigraphical section—a very difficult and dangerous task, by the way—I bring back with me a very meagre collection of their fossils; but these, I think, will prove sufficient to establish a correlation with other tertiary formations in this colony.

*Range of Older Tertiary Escarpment.*—The Bunda tableland is the elevated bed of the Older Tertiary sea, whose sediments were deposited within a very extensive granite basin. Eyre's Peninsula is granitic and metamorphic, the only tertiary strata on it being a fringe of pleistocene on the south coast; similarly constituted is the south-west part of Western Australia, whilst between these great protuberances lie the older tertiary. The edges of the granite base are seen on the east at Yalata, Fowler's Bay, at Pidinga, and Ooldea; on the north at Boundary Dam, and on the west at Point Culver. Between the extremes on the coast—Point Culver, lat. 125 deg. 30 min., and near Fowler's Bay in about lat. 132—the older tertiary rocks follow a gentle curve, the chord of which is about 500 miles in length, and extend seaward for at least eight to fifteen miles from the shore at the head of the Bight, where the depth of water, according to D'Entrecasteaux and Flinders, is from 27 to 30 fathoms. Beyond the base of this tertiary platform a great depression was observed by the late Capt. Owen Stanley, in the Rattlesnake.

For some miles to the west from Fowler's Bay the margin of the older tertiary is for the most part obscured by newer beds, but near Coymbra it forms an escarpment which is traceable around the sandhills at the head of the Bight, and beneath the sand drifts at Peelunibie to where it forms the commencement of the Bunda cliffs. The cliffs hence present a precipitous front to the sea without a beach at the base to within sixteen miles from Wilson's Bluff, thence to that headland a steep slope of consolidated blown sand masks their face. The Bunda Cliffs have a nearly straight trend with a general bearing of west 5 deg. south, but at Wilson's Bluff they curve a little to the north and continue as a bold inland escarpment, called the Hampton Range, having a direction nearly parallel with that of the sea cliffs, curving southward in lat. 127 deg., and reach the sea at fifteen miles to the west of Eyre's Patch or 180 miles from Wilson's Bluff; thence to Point Culver, a distance of 100 miles, the edge of the older tertiary plateau presents a perpendicular front to the sea similar to that of the Bunda.

The whole country between the scarped front of the Hampton Range and the sea is a sandy plain, "Roe's Plains," encumbered with *debris* from the cliffs, and the sea margin with hills of blown sand. The width of this plain varies, as the coast line does not conform with the trend of the escarpment. At Knowsley, 24 miles from Eucla, it is 10 miles; at Mandrabiela, 61 do., 20; at 110 miles from Eucla, 22; at Eyre's Patch, 160 miles from Eucla, 5.

*Geological Sections of Older Tertiary constituting the Bunda Plateau.*—Flinders described the upper one-third part of the cliffs as brown and the lower two-thirds as white, and that the upper brown stratum augmented in proportional quantity as he advanced to the east. Eyre added very little to this brief account in his description of the structure of Wilson's Bluff; he, however, notes the lithological characters of the two bands, and the presence of shells in the upper stratum and of flints in the lower "gritty chalk."

My principal section is that of Wilson's Bluff, which is subjoined, but as an apologetical introduction I may apply to myself the words of Eyre—"Being now at a part of the cliffs where they receded from the sea, and where they had at last become accessible. . . . the part I selected was high, steep, and bluff towards the sea, which washed its base. By crawling and scrambling among the crags I managed, at some risk, to get at these singular cliffs. I felt quite a relief when my examination was completed, and I got away from so dangerous a post." (loc. cit., I. p. 338.)

SECTION OF WILSON'S BLUFF.

[See pl. iv., fig. 3.]

| | Thickness. Feet. | Inches. |
|---|---|---|
| I. Grey to brown crystalline limestone, cast of shells | 50 | 0 |
| II. Yellow friable polyzoal limestone .. .. | 12 | 0 |
| III. *a.* Hard white limestone full of palliobranchs .. | 2 | 0 |
| *b.* { Unseen .. .. .. .. .. | 56 | 8 |
| *b.* { Rough chalk rock .. .. .. .. | 9 | 8 |
| *c.* Layer of Gryphæa, &c. .. .. .. | | |
| *d.* As *b* .. .. .. .. .. | 49 | 8 |
| *e.* Irregular layer of flint .. .. .. | | |
| *f.* White chalk.. .. .. .. .. | 30 | 0 |
| *g.* Flint layer .. .. .. .. .. | | |
| *h.* White chalk .. .. .. .. | 40 | 0 |
| Total .. .. .. .. | 250 | 0 |

Comparative sections made at various points along the cliffs bear out the general observations of Flinders and Eyre respecting the attenuation of the chalky stratum from west to east.

| Succession of strata. | Wilson's Bluff. | Thickness at Stations east from Wilson's Bluff. | | | |
|---|---|---|---|---|---|
| | | 28 miles. | 71 miles. | 90 miles. | 129 miles cliff end, Head of Bight. |
| Superficial deposits of sand and travertine .. .. | | 5 | 40 | 35 | 10 |
| Crystalline limestone .. | 50 | { 92 } | 40 | 49 8″ | 35 |
| Friable polyzoal rock .. | 12 | | 100 | 42 | 80 |
| Chalk .. .. .. .. | 188 | 128 | 60 | 25 | 20 |
| Total .. .. .. | 250 | 225 | 255 | 151 8 | 145 |
| Total thickness of older tertiary .. .. .. | 250 | 220 | 200 | 117 | 135 |

As the several strata were recognised only by colour and appearances produced by weathering, it is probable that the thicknesses given to each stratum may not be absolutely correct, though the thicknesses assigned were determined by measure. Accepting the above data, the crystalline limestone seems to have suffered very little from denudation, or rather, it may be, that disintegration has been equally distributed. Its base shows a fall of 100 feet in a distance of 129 miles, whilst the chalk shows in the same distance a diminution of 168 feet, from which circumstance I am of opinion that the intermediate rock of the eastern sections is coterminous with the chalk rock of the western ones ; both rocks are made up of the same material, though differing in colour and amount and degree of fineness of the earthy constituent. In other words, they have been derived from the one source ; but the distribution of the debris has been regulated in accordance with its different degrees of fineness and distance of transport. The white chalky rock occupies the deeper parts of the granite basin ; whereas the shore deposits are sands and crystallised limestones, as is proved by the sections about Pidinga. (See below.)

The Crystalline Limestone is for the most part fine grained, and varies in colour from white to grey, brown, and pinkish. It is brown on the Bunda cliffs, but on the escarpment of the Hampden Range it is externally hoary, which produces a pleasing contrast with the dark foliage of the scrub clothing the slopes through which the white surface of the rock glimmers. As seen on the coast this band is deeply fissured and cavernous, and is further divided by joints, which cause it to separate into huge cubical blocks.

It occupies the topmost position of the Older Tertiaries throughout the whole extent of the Bunda cliffs, and it crowns the escarpment of the Hampton Range ; it is seen in the same position in the wells and caverns between the Bight and Mallabie, and, so far as is known, makes the surface of the ground over the whole arid portion of the Bunda Plateau ; indeed, it is mainly to this circumstance that the Plateau owes its peculiar characters. It abuts against, and occupies the depressions in, the granite and metamorphic rocks about Pidinga ; where, resting on gneiss, its base is conglomeratic, but where mica slate is the underlying rock a clay intervenes. A section showing the junction of the latter is as follows, taken at the low escarpment bounding the Pidinga rock basin, at about half a mile south of the Talacoutra rock hole. (See horizontal section, pl. iv., fig 1.)

| | feet. |
|---|---|
| Whitish yellow shelly limestone, with cast of fossils... | 3 |
| Yellow clay... ... ... ... ... ... ... | 5 |
| Red and purplish clay, decomposed mica slate, *in situ* | 5 |

At distances varying from 18 to 28 miles north from Colona towards Pidinga, three wells have been sunk in older Tertiary limestone interspersed with sand. The section in the one 18 miles from Colona is as follows :—

| | | |
|---|---|---|
| Surface soil | ... ... ... | 2 |
| Limestone | ... ... ... | 1 |
| Sand ... | ... ... ... | 4 |
| Limestone | ... ... ... | 2 |
| Sand ... | ... ... ... | 18 |
| Limestone | ... ... ... | 33 |
| Yellow sand | ... ... ... | 102 |
| | | 162 |

The limestones are grey to pink, of a highly crystalline texture, and fossiliferous, and of the same general character as the top limestone of the Bunda Cliffs, excepting that some of the limestone debris contains quartz grains. The bottom sand is a sharp yellow to grey quartzose detritus; near proximity of granite rocks is to be inferred.

The crystalline limestone, wherever examined, was found to be fossiliferous; but as the fossils were all in the state of casts I paid very little attention to them, feeling that their specific determination would be accepted with distrust. *Voluta*, *Cypraea*, and *Chione* are common, and I have ventured to attach specific names to a few very familiar forms—*Cassis subfimbriatus*, *Trigonia acuticosta*, and *Placotrochus deltoideus*.

The whole aspect of the stratum points to a correlationship with the upper limestones forming the Aldinga series, and particularly with the uppermost stratum of the older Tertiary about Wallaroo.

Mr. J. Clark, Telegraph-master at Eucla, has presented to me a few fossils and stones picked up by him on the surface at Fairlie's last camp, 80 miles N.N.E. from Eucla. The fossils are undoubtedly older Tertiary, and though their tests are chalcedonized and deeply stained with oxide of iron, yet as the matrix is a yellow crystalline limestone, I would refer them to the horizon of the upper bed of the Bunda cliffs. One species, the *Cerithium*, is not uncommon in the Turritella-marls of the Lower Aldinga series, but the corals are new to the colony. The species are :—*Cerithium nullaboricum*, Tate ; *Plesiastræa*, sp.; *Seriatopora*, sp. (one of the commonest of the reef-building genera in North Australian waters).

The Yellow Polyzoal Bed.—Fallen blocks of marble have attached to them a yellow friable rock consisting for the most part of polyzoal debris, bearing a close resemblance to the main mass of the cliff on the Murray at Mannum, and to some of the lower beds on the west side of St. Vincent's Gulf. It leaves a small quantity of a reddish aluminous residue after solution in acid. The thickness of this band at Wilson's Bluff is twelve feet, its upper surface increasing in compactness, and finally graduates into the overlying marble ; its junction with the underlying stratum is abrupt. The only recorded fossils are *Echinus Woodsi* and *Cellepora hemisphærica.*

Eastward from Wilson's Bluff it increases in thickness, and at the termination of the cliffs has an estimated thickness of eighty feet, the overlying marble being thirty.

The same band was passed through in the wells, and is exposed in the caverns about Mallabie, in the latter under a cover of thirty feet by estimate of marble; as also in a cavern twenty-one and a half miles north-north-west from Mallabie, where *Pecten Gambieriensis* was noted.

WHITE POLYZOAL LIMESTONE.—This, the *piéce de resistance* of the geology of the Bunda Plateau, has a thickness of 188 feet at Wilson's Bluff, where it attains its highest known altitude above sea level. It is a white friable earthy limestone, coarser and harder than chalk, and readily dissolving in acid, without leaving any appreciable residue. On a cursory inspection one is struck by its similarity to the chalk of England, heightened by the presence of layers of black flints and fossils, with a cretaceous facies such as *Salenia*, *Cidaris*, *Gryphæa*, like *G. vesiculosa*, a *Terebratula*, barely distinguishable from *T. carnea*, *Terebratulina*, &c., &c.

In its origin it differs as the debris has been derived from polyzoa; foraminifera, though present, are not abundant.

The section at Wilson's Bluff exhibits the position of the flint layers and fossil bands. The upper part is a hard white stone, ringing under the hammer, full of *Waldheimia*, stained with glauconite, and does not graduate into the overlying limestone. From Wilson's Bluff to the east this band declines at the rate of 1·32 feet per mile, and at the Peelunibie end is only twenty feet thick, by estimate, above sea level. About due north it was reached in a well, 162 feet deep, but the depth penetrated is not known. In no other inland locality is it within view.

This same horizon seems to be the one reached in the wells to the eastward of the Bight, but has there* acquired much silicious property.

The fossils obtained at Wilson's Bluff, all *in situ*, are given in the following table:—

| NAME OF SPECIES. | OCCURRENCE ELSEWHERE. |
|---|---|
| Gryphæa tarda? Hutton. | Lower Aldinga series, Aldinga.<br>Upper Eocene, New Zealand. |
| Plicatula sigillata, Tate. | Lower Aldinga series, Aldinga; Yorke's Peninsula.<br>Lower Murravian, Mannum. |
| Lima armigera, Tate. | |
| Pecten Eyrei, Tate. | Lower Aldinga series, Aldinga; Yorke's Peninsula. |

*An analysis gave a grey pulverulent insoluble residue of 10·64 per cent.

| | |
|---|---|
| **Terebratula subcarnea, Tate.** | |
| **Waldheimia insoluta, Tate.** | Lower Aldinga series. Upper Eocene, New Zealand. |
| **Terebratulina triangularis, Tate.** | Lower Aldinga series. |
| **Retepora sp.** | Lower Aldinga series. L. & M. Murravian, River Murray; Mount Gambier. |
| **Cidaris Australiæ, Duncan.** | Throughout Older Tertiary, *passim*. |
| **Salenia tertiaria, Tate.** | Lower Aldinga. |
| **Echinus Woodsi, Laube.** | Lower Aldinga; L. & M. Murravian. |
| **Eupatagus coranguinum, Tate.** | Lower Aldinga. |

Correlation.—Of the total of twelve species in the chalky rock, ten are well known forms in the lowest Tertiary strata on the shores of St. Vincent's Gulf, which, as I have stated elsewhere (Proc. Phil. Soc. Adelaide, 1878, p. 122), should be placed at a lower horizon than the Lower Murravian. The only other exposure of rock at all resembling the white limestone of the Bunda cliffs is that occupying the shore of MacDonnell Bay, between the township and Cape Northumberland, which also contains flint layers and erect Paramoudra-like masses of flint, comparable in size and shape with those of Antrim, though they exhibit occasionally a somewhat aborescent form, foreign to the Irish specimens. I have no fossils from the MacDonnell Bay stratum. But passing inland, we find at Mount Gambier white, rather granular, limestone, coarser in texture, but containing flint layers. The Mount Gambier bed contains a good many of the fossils characteristic of the Lower Aldinga series, whilst a higher horizon seems to be attained in the yellow polyzoal rock of the Mosquito Plains at Narracoorte. Indeed, the sequence of deposits as determined by fossils and lithological characters would appear to be the same in the south-east as in the Bunda Plateau, excepting that the crystalline limestone of the latter does not exist in the former area.

The Rev. J. E. T. Woods says that "all fossils I have seen from these beds [of the Australian Bight] have been familiar forms from Victorian or South Australian beds. I should imagine, from the description of the beds themselves and the fossils submitted to me that they were nearer to the Mount Gambier formation than those of the River Murray." (Trans. R. S., N.S.W., 1877.)* So far we are in accord, but we are not agreed as to the relative position of the Mount Gambier beds. In 1865 he referred them to the Older Pliocene, placing the Murray beds as Upper Miocene (*vide* Phil. Soc., Adelaide,

* Mr. Woods, in a letter dated August, 1879, writes:—"The fossils I saw from the Bight were entirely like those of the Murray Cliffs in character—a yellowish limestone, and the fossils mostly in casts. I recognised in them a few Mount Gambier forms." His remarks, therefore, apply only to the top limestone of the Bunda Plateau.

1865); and in 1877, in a letter to me, he writes:—"I am surprised, pleased, to find that the Muddy Creek beds are above the Murray Cliffs; but what surprised me most is that you regard the Mount Gambier beds as lower than either. This I certainly did not expect, though I admit I had no good reasons for my opinion."

Neglecting the lower half of the chalk rock of the section at Wilson's Bluff, as from it I only gathered one fossil *(Lima armigera)*, I find that the *tout ensemble* of the Bunda cliff and Blanche Point cliff, Aldinga, to be the same. I cannot deny that my opinion is not well supported by palæontological observations, and that the lithological characters seem to be widely different. Respecting the latter, it is after all more apparent than real, and the Aldinga section, in some of its details, closely resembles that which exists on a grander scale in the Bunda cliffs. The band in which *Salenia* and *W. insoluta* occur is at Aldinga a white limestone, with glauconitic grains; and the bed under the top limestone is at many places as highly charged with polyzoal debris as the middle band in the Bunda cliffs. I must declaim against my opinion touching the correlation of the older Tertiary of the Bunda cliffs as being a mere guess. It is certainly something more than what is vaguely called an impression, for I have some basis for my opinion, which is corroborated by that kind of intuitive perception of the relation of things which comes from frequent contact with the object of study in all the varying phases which it presents.

For these and the explicable reasons which I have stated I see in the Bunda cliffs a stereotype of the Aldinga section, with only a slightly different coloration.

*Minor Features.*—The crystalline limestone is not a rock absorbent to water, as may be inferred from the fact that all the rock-water holes are in it; but because of the many joints and fissures which vertically penetrate its whole thickness, the rain which falls on its surface is immediately lost to view, and sinking through the yellow polyzoal bed, is somewhat detained or directed to the front of the cliffs by the band of hard chalk.

Around Wilson's Bluff, where the yellow polyzoal bed is thin, and the top of the chalk high up in the cliffs, it is only the crystalline limestone that presents a perpendicular face, whilst the long slope of chalk is encumbered with the blocks of the upper bed set free by their weight pressing down on the moistened surface of the chalk. This action has originated the gulleys or steep-sided ravines which indent the escarpment of the Hampton Range and the western 26 miles of the Bunda cliffs. They do not penetrate beyond a few hundred yards from the front of escarpment, or, in the case of the Bunda cliffs, a few hundred feet.

Further east along the Bunda cliffs the top bed and its underlying polyzoal limestone is perpendicular, or even overhanging, that part of the chalk within the influence of the ocean swell being hollowed out. By the combined action of percolating water from above and the sea waves below great masses of the upper part of cliff are seen at short intervals forming protecting buttresses to jutting points. The front of the seawall is washed in all states of the tide, and follows a curved line, the chords of which are about eight to ten miles long, with subordinate serrations. On looking forward or backward, as the case may be, one serration is seen projecting beyond the one preceding it to the end of the long curve. Each projection has a talus as remarked above, and the indent between each is in length five or more hundred yards, but with a long curve towards the east, and the shorter one directed towards the west.

This general appearance of the coast cliffs is modified at places by the occurrence of slides of greater magnitude than ordinarily. The first effects of the movement of the upper beds on the chalk is visible on the surface in the form of long crevasses parallel to the edge of the cliff, and at distances from it of a few to many yards.

The caverns, which are many on the Bunda Plateau, are excavated in the crystalline limestone, and extend down into the underlying friable band. Their presence is indicated on the surface by crateriform depressions, in the centre of which is the perpendicular aperture to roomy excavations, the roof of which in many places rises nearly to the surface in the form of inverted pot-holes. Though slight signs of waterflow from the edge of the depression to the aperture are visible, yet in the interior there is no indications of percolating water. The earlier stages of the formation of the cavern are those perpendicular vents called blow-holes, up which there rushes on hot days a violent wind, which may also be heard coursing along the lateral passages with the sound of a mill-race. From the known widely-fissured and cavernous character of the crystalline limestone as seen on the coast, there can be little doubt that the stratum throughout its whole extent presents continuous air passages. The air in the passages and caverns in the interior part of the plateau acquires a higher temperature during the day than that on the face of the sea cliffs, in consequence of which an indraught is caused towards the hotter region. On one occasion I compared the temperature of the air as it flowed from a blow-hole with that in the shade of a tree. The shade temperature was 78 deg., and the same thermometer suspended two feet within the blow-hole registered, after the lapse of three minutes, 70 degs.

The post-miocene rocks of the Bunda Plateau are comparatively so insignificant, and because they form part of a series which elsewhere assume considerable proportions, I will include them in my general account of that group of strata.

## The Newer Tertiaries around the Head of the Great Australian Bight.

Between the Head of the Bight and Fowler's Bay the surface is occupied with loamy and grassed flats alternating with sandy ridges covered with mallee. The grass flats are margined with spurs and terraces thickly covered with travertine. Wells have been sunk on the travertine, and the older tertiaries passed through to depths up to 180 feet or more, water being always met with in a grey silicious limestone, which may be coterminous with the chalky rock of the Bunda cliffs. The water is more or less brackish, but for the most part the quantity and quality increases towards the coast.

The sand, which crowns all the higher ground inland, is probably derived from the waste of the granitic and quartzitic rocks to the north. Though the period of its formation is uncertain, yet I venture to suggest that it is of fluviatile origin, and is coterminous with the plant-bearing sandstones of Ardnamukka, on the west side of Lake Torrens.

Excepting the Bunda cliffs, the whole coast line of the south-western part of this colony is constituted of post-miocene rocks. The prevailing subter-structure of the country between Eucla and Fowler's Bay is that of the older tertiary limestone, and between the latter place and Port Lincoln it is that of metamorphic rock, chiefly mica-schist, through which protrude granitic masses, overlain by derivative material, and flanked on the seaboard by more or less consolidated calciferous sands. The latter section of the country is represented on Brough Smyth's geological map of Australia as occupied with tertiary strata, but as I have shown (ante p. 103), the older tertiary of this western country occupies a well-defined basin, and is not coterminous with that of any other part of the province. Most of the trigonometrical stations and the higher elevations eastward from Fowler's Bay are granitic.

Eastward from the Head of the Bight, the whole coast line is flanked by sand dunes, generally based upon a false-bedded consolidated sand ; which, however, occasionally attains a moderate elevation above sea level. All the bluffs are composed of the consolidated sand, and by its oblique lamination and rapid decay of portions, there result those fantastic and picturesque rock faces, needles, and scars which contribute so much to relieve the prevailing monotony characteristic of this coast.

These æolian rocks extend several miles inland at various places, and from the large amount of calcareous matter which they contain there has been formed by its solution and by transpiration towards the surface, and precipitation there, a limestone crust or a stratum of consolidated sand. For the most part this crust occupies the present surface, and may be best studied about Streaky Bay and thence to Bramfield. But other layers are frequently visible, which have doubtlessly been formed under similar conditions, and which mark older surfaces. The sands and consolidated beds contain land shells, which are often met with imbedded at great depths below the surface. The following section on the coast near Fowler's Point illustrates the leading characteristics of these aerial deposits:—

| | Feet. |
|---|---|
| Loose sand, white in colour, rising to considerable elevation in from the edge of the cliff. | |
| Travertine and limestone breccia in rude courses, overhanging ... ... ... ... ... ... ... | 10 |
| Sand layer mixed with lumps of travertine and blackened angular fragments of limestone, presenting a very scoriaceous appearance; land shells in abundance ... | 2 |
| Sand rock: consolidated coarse yellow-red sand in thick wedged-shaped courses; weathering into stalactitic or columnar-like form on the face, and also honeycombed | 40 |

At Fowler's Bay the travertine band comes down to the sea level, where it forms reefs, and the whole cliff seems to be made up of shifting sand. Similarly it falls to sea level at Fowler's Point, leading one to infer that a sandbank had become elevated, then had acquired its calcareous crust, and in later times become buried by blown sand.

The sand dunes have in many places barred extensive bays and creeks, such as Lakes Hamilton and MacDonnell; which in other instances have been subsequently silted up, and by elevatory movements are now shallow salt pans or lagoons, such as the Yalata and Peelunibie Swamps.

The Yalata Swamp is not more than two feet above high water mark, it is an extensive basin, occupied with yellow or white clayey sand. Around its margin is a loose shell sand, surmounted by a white shell-limestone full of bivalves with valves in apposition. The general level of the top of the recent marine bed above the swamp is four feet; or six feet above high water mark. A more recent deposit in the form of a sheet of travertine of about six to nine inches thick at the greatest, spreads over the shell limestone and the shell sand, and has enclosed the shells of the latter.

As elsewhere in the colony, these recent marine-beds contain the usual assemblage of shallow water forms of the present coast line, but in addition are characterised by the abundance of individuals of a few species either very rare or extinct in our waters. In the Yalata deposits, the most notable are *Arca trapezia*, *Cryptodon ovulum*, *Dentalium Tasmanensis*, and *Columbella australis*. The sand drift inside the dunes of the "Roe Plains" at Eucla rests on a calciferous sandstone, containing the common shells of the present coast. The shells of the Mactræ and other bivalves, being in apposition, prove that the fossils lived and died on the spots where now found. The highest elevation at which these evidences of recent oscillation of level were seen is at about twelve feet above high water.

As previously stated (p. 104), the Bunda cliffs are at their extremities fronted by an undercliff of consolidated blown sands, which belong to the series of æolian deposits just described. Plate iv., fig. 2 exhibits the manner in which they have been accumulated in front of the sea wall, have acquired some debris from the cliffs, and have streamed over upon the crown of the escarpment; the truncated seaward face of the undercliff is characteristic not only here, but of other parts of the coast line. That the sands, which form the knolls on the seaward edge of the Bunda Plateau referred to at p. 99 have been blown up from the shore is indicated by their mode of occurrence, and by the nature of the material, which I find to consist of rounded grains of limestone dissolving freely in acid and leaving an aluminous and sandy residue of about 7·6 per cent.

The sands which cover the Bunda cliffs are more often consolidated, especially in the lower portions; and alternations of sand, sandrock, and travertine generally prevail in all the sections. Not unfrequently the loose sand beds are penetrated by stalactitic masses of consolidated sand, and have in them erect stole-like masses of the same material in various shapes and sizes, the latter ranging up to one foot in diameter and up to a height of two and a half feet. They must have originated from the precipitation of carbonate of lime around roots, branches, and stems of shrubs, whilst they possessed consistency; and the cavity which was formed by the subsequent decomposition of the vegetable matter was filled by the same process. Similar concretionary bodies have been described by Flinders, as entombed in the calciferous sands of Bald Head, King George's Sound; but he mistook them for corals, whilst the true explanation of their origin was left to Charles Darwin (vide Journal of Naturalist, 12 ed.. p. 450). And their occurrence in the sand dunes at various points on the southern coast line of this continent is now well known.

Though I cannot disabuse my mind of the belief that the whole front of the Bunda cliffs was once faced with blown sands, in continuation of the now terminal portions, yet I cannot reconcile it with the fact of the existence of deep water so near the shore of a coast line without a beach, without admitting the necessity of some considerable elevation to form a beach. The truncated littoral margin of the cliffs of consolidated sand evidences loss by marine denudation, and extension seaward. The depression that is demanded by the present position of the recent marine deposits of Roe Plains, Yalata Swamp, &c., militates against the opinion that the consolidated blown sands and marine deposits are synchronous. In fact, the only explanation to meet the requirements of the case is that during the formation of the consolidated sand the coast line was much further seaward than now; since then a depression, perhaps not exceeding twenty to thirty feet, below present sea level, followed by an elevation which seems to be progessing at this time.

The higher antiquity of the consolidated sands may be indicated by the use of the term "Pleistocene," whilst the later deposits may be spoken of as "Recent Marine" and "Sand Dunes."

The oolitic limestones described by Eyre as covering much of the surface of the country from Fowler's Bay to beyond the Head of the Bight can only be the travertines and sand rocks containing fragments of limestones, such as I have described at Fowler's Point.

The fragments in these limestone breccias, or as enclosed in concretionary travertine, are usually black, irregular in outline, and their surfaces more often pitted or weathered; from which appearance one might be well excused from committing the error, on a cursory examination, of calling them scoriæ. One source of the black discoloration of the usually light-coloured tertiary limestones is the carbonization of the fatty matter of animals which has penetrated into the stones, in the process of cooking *à l'aborigine*; and is probably the true explanation of the black nuclei to the concretionary travertines which are not unfrequently found on the cliff tops over the River Murray and about the shores of St. Vincent's Gulf. But on the Bunda Plateau, such stones are too widely spread, and often too far from the haunts of the aboriginals to have been blackened by such agency. My attention was aroused too late in my journeyings to make any very extended observations, but this much I noticed—that the samphire-covered depressions (see post p. 120), where surrounded by outcrops of limestones, were strewn over with black angular stones; in some the discoloration had not penetrated far beyond the surface, and these stones could at once be identified, with either the crystalline limestone or the travertine crust. The colour which is discharged on submitting the stones to a red heat, is doubtlessly of a vegetable source; not due to the growth of algals, because too deep and lasting, but to the imbition of vegetable infusions, and their subsequent partial decomposition or carbonization.

The recent sand dunes on the Bight coast attain considerable elevations where they rest upon the Pleistocene sands or upon the older tertiary escarpment; the colour of the sand is usually dirty-white or grey, sometimes snow-white, but never of the reddish hue of the older series, though like them they contain a very high percentage of calcareous matter. The view presented by the Peelunibie sand dunes, at the Head of the Bight, as seen on a bright sunny day, is one not likely to be effaced from the memory. To all appearance we were looking towards a high mountain range whose base was encumbered with dark-coloured rocks, and whose crown was laden with snow. The illusion was strangely perfect, for the so-called snow and the rocks were as uniform and apparently consistent as though they were the genuine components of an Alpine landscape. As we approached, the wonderfully beautiful and refreshing spectacle gradually lost its grandeur, through diminution of its apparent height and massiveness; and finally the black coloured rocks were seen to be the dark green foliage of bushes, and the snow to be the domed tops of white sand dunes whose bases were clothed with shrubs. The whiteness of the sand is due to the fragments of bleached shells of *Donacilla elongata*, which constitute the whole or nearly the whole of the coarser part of the sand; whilst the finer part, which is less than a moiety, is comminuted shelly matter, though of not so white a colour. These sands have a maximum elevation of 180 feet, but this height is only attained where they have surmounted the escarpment of the older tertiaries.

The only permanent water in the country around the Bight is derived from the sand dunes and Pleistocene sands. Water is, however, not always procurable in the sand dunes, the supply being most abundant in those which are devoid of vegetation. At Fowler's Bay water is thrown to the surface by the pipe-clay of the Yalata swamp; but in most instances the fresh water is simply buoyed up by the sea water.

The Soil of the Bunda Plateau is a reddish coloured loam or loess, and near the coast has a thickness of as much as eight to ten feet; and in its upper two feet or so is crowded with the shells of *Helix* and *Bulimus*. Its thickness diminishes beyond the northern boundary of the oasis, and in the more interior parts visited by me it is confined to slight depressions in the prevailing limestone surface. It is evidently the residue of the disintegration of the miocene limestone, an analysis of which shows it to contain about six per cent. of insoluble matter. Its limited extent in the interior tracts is doubtlessly due to a combination of circumstances reciprocal in their action. The absence of timber and almost of vegetation does not favour its formation nor its retention. The moistening vapour of the sea breezes does not reach the interior to clothe the parched and naked rock. What little is formed is for the most part removed by the action of the wind, and transported to those parts where conditions prevail favourable for its retention.

## Meteorology.

Very little is known respecting it, and observations have only recently been commenced at Eucla and Fowler's Bay. The rainfall around the Head of the Bight is very small, and is mainly brought by the south-east winds. Heavy rains are unfrequent; and that the prevailing rains are of the nature of coast showers is evidenced by the diminution of rain in advancing in a north-west direction from Port Lincoln, as exhibited by the following records extracted from "Meteorological Observations," by C. Todd, C.M.G., &c. :—

| Year. | Port Lincoln. | Streaky Bay. | Fowler's Bay. | Eucla. |
|---|---|---|---|---|
| 1876. | 16·210 inches | ... | ... | 11·330 |
| 1877. | 22·440 " | ... | ... | 13·775 |
| 1878. | 17·290 " | 16·135 | 10·314 | 5·892 |

The number of days on which rain fell during 1878 was at Port Lincoln, 115; at Streaky Bay, 77; at Fowler's Bay, 74; and at Eucla, 65.

Independent evidence of the above nature is furnished by the officers of the survey schooner, obtained during the autumn of 1879, between Fowler's Bay and the Head of the Bight:— "It is strange that very much more rain falls in the sea near the shore on this part of the coast than on the land, and on one occasion nearly two inches of steady rain fell in six hours. Within ten miles of Fowler's Bay and at the tidemaster's tent at Fowler's Bay there was none at all."—*S. A. Register*, May 27, 1879.

One proof of the scarcity of rain and the rarity of rain storms on the Bunda Plateau is the fact of the preservation to this day of the tracks of the horses forming Forrest's equipment which were made in July, 1870.

From the general character of the rainfall on the coast it may be inferred that the amount is less at the Head of the Bight than at Fowler's Bay or at Eucla, and that it decreases as the distance from the coast increases. Indeed, the aspect of the vegetation demands that such is the case.

Thermometric readings taken exclusively on the Plateau, and embracing a period of twenty days in the month of February, give a mean temperature of 75 deg. at 9 a.m., and of 87 deg. at 3 p.m. The highest temperature recorded was 109 deg. on the 4th. The changes of temperature were pretty regular; at 9 a.m., 75 deg.; at 3 p.m., 87 deg.; at 6 p.m., about 75 deg.; cooling rapidly after sundown, and becoming bitterly cold between 4 and 5 a.m. Only on a few occasions did I note the temperature at these early hours. The following table exhibits the range of temperature observed on four days:—

| Date. | Time. | Temp. | Diff. |
|---|---|---|---|
| Feb. 2 | 5·30 a.m. | 58·5 | 36·5 |
| | 3 p.m. | 94· | |
| " 3 | 5·15 a.m. | 55· | 54· |
| | 3 p.m. | 109· | |
| " 18 | 7 a.m. | 54· | |
| " 22 | 6·23 a.m. | 44· | 38· |
| | 3 p.m. | 82· | |

The unusually cold mornings betokened hot days, and the greatest difference of temperature of 59 deg. was recorded on the 28th of January, while at Coymbra. At 4.30 a.m. the temperature was 53 deg., at 9 a.m. 94 deg.; and the maximum was 112 deg.

In consequence of the calm and clear nights, and with a temperature frequently falling below dew point, dew should be copiously deposited; but it seems that the atmosphere over the dry surfaces of the interior part of the plateau had little or no moisture to give up during the time of my sojourn, as no dew was observed. But near the coast there was frequently a copious precipitation of dew, and it was a matter of observation that the quantity rapidly diminished inland, and beyond the limits of the timber trees appeared to be nil.

## Botany.

The number of plants inhabiting the Plateau is very small, and is for most part made up of shrubs or shrubby perennial herbs. Some species appear to be confined to the rocky edges of the cliffs, such as *Correa speciosa*, var. *magnifica*, *Eremophila Browni*, *E. alternifolia*, *Goodenia varia*.

Whilst the under cliff of consolidated sand, which extends for about sixteen miles east from Wilson's Bluff, yields a number of species not met with on the Plateau, though familiar plants beyond it, conspicuous among which are *Lavatera plebeia*, *Scævola crassifolia*, *Nitraria Schoeberi*, *Templetonia retusa*, *Kochia oppositifolia*, *Enchylæna tomentosa*, *Oxalis corniculata*. These plants here find favourable conditions for growth arising from the depth of drift material brought down from the edge of the Plateau, which retains much of the accumulated rainfall gathered in the gully-like channels which seam the face of the cliff slope. Here a luxuriance of grass prevails, not only in the watercourses, but along the cliff slopes below the level of the crystalline limestone. Their roots here find moisture, and protection is afforded them from the sun's rays by the rocky *debris* which encumbers that part of the cliff slope.

The Bunda Plateau on its western edge is bounded by a belt of mallee and tea tree, which continues along the edge of the escarpment to near Wilson's Bluff, whilst parallel to the coastline it is situated at about from two to three miles from the edge of the cliffs. At about 20 miles from the escarpment over Eucla the mallee, which appeared among the other trees at a few miles to the east, begins to predominate, and for fifteen miles forms a dense scrub. Tracing it around the coast it soon thins, and on the meridian of Mallabie is about one mile wide, open, and the trees of low stature. To the east of this the mallee disappears, and is not again seen till the margin of the Peelunibie sandhills is reached; thence it continues in a generally north-east direction, and occupies the surface of the sandy country southward to the coast. However, the extensive sandy region resting on the east side of Pidinga rock-basin is covered with a thick, not dense, scrub of mulga (*Acacia* sp.).

Lying inside the belt of mallee scrub is an extensive oasis occupying a breadth of from six to ten miles on either side of the telegraph line, which thus nearly traverses its longer diameter. Its dimensions are 110 miles long and its average width eighteen miles, or an area of about 2,000 square miles. Throughout this oasis mulga and sandalwood are the only trees. These occur thinly scattered where the soil is loamy, but are clustered on the travertine surfaces. This open country is well grassed, the grassed parts interspersed with blue bush (*Kochia sedifolia*), *Scævola spinescens*, *Fusanus acuminatus*, &c., sometimes the bushy plants dominating over wide areas. Intervening between the mallee scrub and the coast is a sterile belt, with occasional tussocks of harsh grasses, almost leafless *Scævola spinescens*, stunted *Choretrum glomeratum*, now and then with dwarfed *Nitraria Schoeberi*, and saltbush (*Atriplex* sp.), but for the most part carpeted with a prostrate *Melaleuca* and *Eucalyptus*, and *Eremophila densifolia*. The habit of the two myrtaceous plants is clearly due to the action of the wind, because as they retire from the coast they graduate into low bushes, and gradually acquire their usual stature. At eight to ten miles from the coast, particularly on the eastern side of the Plateau, the effect of the wind on the sandalwood trees is strikingly apparent in their wand-like trunks and branches and leafy crowns, looking like mallee, bending to the north-west, in which direction they are forced by the strong winds from the south-east which prevail at their chief period of growth.

One characteristic feature of much of the vegetation of this western part of the coast tract is its heath-like habit, as seen in *Melaleuca*, *Eremophila densifolia*, F.M., *var.*, transporting one mentally to the Scotch moors or those of North England.

At about halfway between Eucla and the head of the Bight sand begins to appear, and with it a change in the vegetation, grass increases in quantity, the broom-like *Eremophila* appears, and most of the heathy plants become sparse or disappear. This change is very gradual, but becomes the greater as the extent covered by the sand drifts is widened.

To the north of the oasis there is a treeless region, called on the maps the Nullarbor Plain. It is, however, structurally a part of the Bunda Plateau, and there is no abrupt line of demarcation between it and the oasis. My notes having reference to the aspect of the vegetation on the N.W. journey from Mallabie are as follows :—

At 6 miles.—Grassy with few sandalwood trees and low bushes; signs of drought, as does a good deal of the country already passed over.

At 9 miles.—Much broom-like *Eremophila (E. scoparia)*, stunted fusanus *(F. acuminatus)*, *Choretrum glomeratum*, *Olearia conocephala* (bluebush), and a few sandalwood trees.

At 16 miles.—Treeless, much broom, little bluebush.

Beyond 21 miles.—Broom low and scanty; saltbush and prickly *Scævola* abundant but mostly dead, patches of shrubby samphire *(Salicornia arbuscula)* around bare subsaline surfaces of red loam in the slight depressions of the ground. Tufts of dead grass occasionally.

The contrast of colour presented by the vegetation on this arid interior is very striking, and is best exhibited in the N.E. part of it. On the slightly rising ground a blue tint prevails from the massing together of the blue bushes of two species, *Kochia sedifolia*, *Olearia conocephala*, and over the depressions of the surface the colour is dark from the black-green or almost black of the samphire, whilst intervening between the two colours is a gray belt produced by the salt bush (*Atriplex* sp.)

The interior has a few peculiar plants, but is characterised by paucity of species and their depauperised state. On the 22nd February, the total number of plants observed throughout the day's journey of 21 miles, was only fifteen, including bluebush, cotton bush, saltbush, samphire, *Salsola Kali*, *Zygophyllum* sp., *Sclerolæna diacantha*, some withered composites, a grass, and other annuals. Around our camp on Feb. 3 a fewer number was seen.

The depauperization of species is not altogether attributable to the absence of soil, for long before the crystalline limestone forms the surface of the ground, reduction of size and disappearance of species is observable. The main cause must be hygrometric. Rain when it falls must rapidly pass away by absorption over much of the area, or by evaporation from the less pervious surfaces, which, judging from the extreme dryness of the air must be very active, but the rainfall is certainly very small, and precipitation of dew barely possible. That the vegetation has a struggle to maintain itself against such adverse conditions is evidenced by their stunted growth, absence of flowers or fruit, and generally by the blackened, and decayed or decaying appearance that it presents as a whole. Grass in most places was recognised by blackened spots on the surface, whilst the numerous dead or partially leafless shrubs attested to the long period which had elapsed since sufficient rain had fallen to produce growth, or flowers and fruits. Further, whilst all the plants of the desert tracts excepting *Eremophila scoparia* presented no traces of flowers or fruit; individuals of the same species were met with elsewhere in different stages of maturity, and the yellow straws among the blackened tufts of grass bespoke a recent growth. It is probable that after continued rain a vigorous growth of vegetation takes place, grass and other annuals appear, and for a few weeks all seems verdure, but is followed by prolonged droughts, during which the perennial plants only can continue to live.

The Bunda Plateau is perhaps the least Australian in its botanical features of any part of the continent. The absence or fewness of species of *Proteaceæ*, *Thymeleæ*, *Pittosporeæ*, *Leguminosæ*, and *Myrtaceæ* make this part of Australia quite an anomaly. One can hardly conceive of so vast a tract without gum-trees, casuarinas, grevilleas, hakeas, banksias, xanthorræas, pimeleas, xerotes, ferns, &c. The desert character of the flora is indicated by the numerical strength, either of individuals or species of *Chenopodiaceæ*, such as *Kochia*, *Rhagodia*, and *Atriplex*, *Compositæ*, *Eremophila*, &c., and by the absence or rarity of *Proteaceæ*, *Myrtaceæ*, *Epacrideæ*, &c.

## List of Species of the Bunda Plateau.

Note.—The species marked by an asterisk have not yet been discovered beyond the limits of this region. Those marked thus †, are recorded for the first time as occurring within South Australia; or are not included in Schomburgk's Flora of the Province.

### Order Cruciferæ.

* † Blennodia Richardsi, F. M. *(Richards.)*

† Capsella pilosula, F. M. *(Richards.)*
* † Capsella Drummondi, F. M. *(Richards.)*

ORDER MALVACEÆ.

Lavatera plebeia, Sims, of very slender habit and purple flowers. Bunda undercliff.
† Hibiscus Farragei. *(Richards.)*

ORDER ZYGOPHYLLEÆ.

Nitraria Schoberi, Lin., edge and slopes of Bunda cliffs towards the west.
Zygophyllum Billardieri, Dec. (*Richards.*)
† Zygophyllum glaucescens, F. M. (*Richards.*)

ORDER GERANIACEÆ.

Oxalis corniculata, Lin. Slopes of Bunda cliffs on the west.

ORDER RUTACEÆ.

Correa speciosa, Ait., var. magnifica. Rocky parts of Bunda cliffs.

ORDER LEGUMINOSÆ.

Templetonia retusa, R. Br. Sandy parts of Bunda undercliff.

ORDER MYRTACEÆ.

Eucalyptus, sp., and Melaleuca sp. See. p. 119.

ORDER LORANTHACEÆ.

Loranthus linophyllus, Fenzl. On *Acacia* sp., edge of desert tract.
Loranthus pendulus, Sieb., var. melaleucæ, Lehm., on *Fusanus*.
Loranthus Exocarpi, Behr., on Melaleuca.

ORDER COMPOSITÆ.

Minuria leptophylla, Dec. (*Richards.*)
Toxanthus Muelleri, Benth. *(Richards.)*
† Helipterum roseum. *(Richards.)*
* † Helipterum Haigii, F. M. (*Richards.*)
† Helipterum tenellum, F. M. Between Fowler's Bay and Eucla. (*Richards.*)
* Cephalipterum Drummondi, A. Gray. In the interior from the Head of the Great Bight. (*Delisser.*)
Ixiolæna tomentosa, Sond.
Olearia conocephala, F. M., (blue-bush). Widely diffused over the Plateau.
Brachycome graminea. Sandy soil, edge of Bunda cliffs.
* † Brachycome Tatei, F. M (MS.) Rocky edge of Bunda cliffs.
Senecio Cunninghami, De C. Sand patch near Wilson's Bluff.

Sonchus oleraceus, Linn. var. Sand dunes near Wilson's Bluff.

ORDER GOODENOVIEÆ.

Goodenia varia, R. Br. Rocky edge of Bunda cliffs.

Scævola crassifolia, Labill. Sandy undercliffs on western part of Bunda Plateau.

Scævola spinescens, R. Br. Widely diffused over the Plateau.

ORDER MYOPORINEÆ.

Eremophila Browni, F. M. Rocky edge of Bunda cliffs west.

Eremophila alternifolia, R. Br. With the last.

† Eremophila Weldi, F. M. Variety with roundish leaves. Bight Plateau.

* † Eremophila Delisseri F. M. (cotton bush). On the east side of the plateau, between head of Bight and Pidinga. The type specimens were obtained by Delisser, N.W. of the head of the Great Australian Bight, in Western Australia.

Eremophila scoparia, F. M. (broom). Over the desert tracts, very abundant.

† Eremophila densifolia, F. M., var. On the south-west and west margins of the Plateau.

ORDER CHENOPODIACEÆ.

Rhagodia spinescens, R. Br. Under shelter of trees, edge of desert.

Chenopodium nitrariacea, F. M. Sandy undercliff, Bunda Cliffs west.

Atriplex sp. (saltbush). Common over Nullarbor Plain.

† Atriplex phlebocarpum? ("large saltbush.") About Coompana, in the oasis.

Enchylæna tomentosa, R. Br. With *Chenopodium nitrariacea.*

Kochia oppositifolia, F. M. Slopes of Bunda Cliffs west, and by seashore.

Kochia sedifolia, F. M. (*blue-bush*). Widely diffused, but sparingly in arid parts.

Sclerolæna diacantha, F. M. On stony surfaces in arid parts.

Salicornia arbuscula, R. Br.. Widely diffused in desert tracts.

Salsola Kali, Lin. Occasionally in arid parts.

ORDER LAURINEÆ.

Cassytha sp. Rocky slopes of Wilson's Bluff.

ORDER SANTALACEÆ.

Fusanus acuminatus, R. Br. Widely diffused.

Choretrum glomeratum, R. Br. (*mamla*). Widely diffused.

The species collected by Corporal and Mrs. Richards, of Fowler's Bay, are inserted on the authority of Baron von Mueller (*Fragmenta Phytographiæ Australiæ.*) The specimens of the Richards-collection were gathered on the Bunda Plateau, though "*prope* Eucla."

In the determinations of the species collected by myself I have been assisted by Dr. Schomburgk; but some critical species have been named by Baron F. von Mueller.

ZOOLOGY.

From the botanical features of the Bunda Plateau much might be anticipated regarding the distribution and character of the constituents of its fauna; where the richer flora prevails there live the greater number of species and individuals. The numerous deserted burrows of animals which were observed in the desert tracts seem to point in the same direction as that indicated by the plants; that is, to continued droughts.

*Class Mammalia.—Canis dingo* is widely spread, and was seen farther inland than any other mammal. Though reddish-yellow is the common colour of its fur, yet black is not rare, and white has been observed. The crevices of the Bunda cliffs are its favourite resorts, and a well-beaten track extends along the edge of the cliff from end to end.

*Macropus fuliginosus* is the only kangaroo; it was not abundant, and was seen only in the lightly-timbered parts.

*Bettongia campestris*, or weelba, is the commonest mammal in the oasis; and though exceedingly timid in the day time, exhibits little fear of man at night, and is a daring thief. The flesh much resembles rabbit.

*Phascolomys*, sp., occupies the eastern half of the Bunda oasis, and extends far inland. It would appear to have here reached its western limit. This wombat is very distinct from the species near Adelaide, and is identical with that named *P. niger* in the Institute Museum. I have not, however, adopted that name, as I am not aware that it has been published, and because it is rather inappropriate. The fur or *soft hair* is a mixture of black and grey on the back, light coloured below. The animal lives in deep burrows, chiefly excavated in the loamy soil to depths of seven or eight feet, or under the travertine cover; it is the chief animal food of the wild aboriginal.

*Perameles* was not seen alive, but its remains were found in the caverns frequented by owls.

*Hapalotis conditor*, or walkla. This small rodent, conspicuous by its large ears, is known as the building hapalotis, from the circumstance that colonies of them erect over their burrows massive structures of interlacing small branches. It is the chief food of Strix N.-Hollandiæ which inhabits this country.

A small mouse-like animal—whether a rodent or a marsupial I cannot say, not having seen it—would seem to have been very plentiful at one time in the arid tracts, as its long shallow burrows—which it is said to close with small stones—were conspicuous objects all over the treeless country, wherever there was a sufficient depth of soil.

*Class Aves.*—A moderately great variety of birds was observed in the oasis. *Strix Novæ-Hollandiæ* finds a suitable retreat in the caverns; whilst *Aquila audax* was not unfrequently seen, and hunting in pairs. *Corvus australis* clings to the neighbourhood of the water-holes. *Cacatua Leadbeateri* would seem to be almost a straggler in this region, as only one flock was seen; and singularly at about the same place that Eyre met with the bird. In the oasis, particularly in its western parts, several species of parakeets were observed, though not identified. A lark inhabits the coast tract, whilst small finches, flycatchers, honeysuckers, emu wrens, *Geobasilus regulus*, and *Lichmera Australasiana*, are common in the timbered region. The ubiquitous bustard, *Choriotis australis*, is widely spread.

*Class Reptilia.*—Of Ophidians I saw but few individuals of not more than four species, and all within the oasis. *Pseudechis porphyriacus* (Shaw), black snake; *Hoplocephalus minor* (Gunther), desert snake; *Acanthophis antarctica* (Wagler), death adder.

Lizards were met with over a much wider area; indeed, they occur where no other conspicuous form of animal life were to be seen, though in the latter case the species were a small *Mocoa* and a small *Grammatophora*. The species observed were: *Monitor Gouldi* (Gray), iguana, in the oasis; *Trachydosaurus rugosus*, sleeping lizard, widely spread; *Egernia Cunninghami*, near the coast; *Diplodactylus marmoratus*, under stones along the cliff edge. *Grammatophora*, n. sp.? seven inches in length, colour of back, yellowish-brown banded with white; *Grammatophora*, n. sp.? similar in size and coloration to *G. Adelaidensis*, but differing particularly in the depressed head; *Grammatophora*, sp.; *Hinulia*, two sp.; *Mocoa*, two sp.

The class Insecta is represented by several brilliant and one very large yellowish-brown species of *Stignoderma*; a very large chesnut brown diurnal longicorn; many vespidæ, singularly shaped ichneumons, large dipters, all of which are attracted by the fresh blossoms of mallee and teatree. Clicks, weevils, and ground beetles of the family *Brochidæ*, the latter characterised by nodosities on the elytra. One of the largest Brochidæ emits when handled a brown fluid from its mouth, and produces a noise audible at the distance of several yards by rubbing the depressed sides of the abdomen against the thickened and incurved edges of the elytra; another, but smaller, species is widely spread, and is the chief food of the *Grammatophoræ*. An interesting form of Elaterinæ was captured, one inch long, and of a brown colour marbled with white. Two small species of butterflies, an *Ogyris* and another, were seen in the oasis. A few species of *Blattidæ* are active during the daylight, but I never saw a single winged form. One small species which is common has the upper surface studded with small tubercles and longitudinal ridges. A species of *Polyzosteria* as beautiful as *P. Mitchelli*, Angas (*Blatta*), was also taken; it differs from it a little in shape, but chiefly in the coloration.

Spiders are chiefly represented by large *Lycosæ*, whose open vertical burrows, lined with web, are to be found wherever the soil is suitable. One species was noted to have the cephalothorax brown with black rays, thighs black, rest of legs grey, abdomen with bands of black and grey. Some nondescripts were collected; but, like all the soft-bodied animals when placed in the spirit-bottles, they did not withstand the disintegrating effect of camel transport. A singular form was captured on the grey surface of a stone near Wilson's Bluff, which was of a dirty colour, and had a prehensile abdomen—that is to say, that part of its body was much depressed and somewhat narrowed posteriorly, which, when the animal was touched, was firmly applied to the angular edge of the stone on which it rested. In this squat attitude it looked like a small lump of dirt, and, confident in its powers of mimetism, it refused to be roused into activity. Several times did I change its position, but in every instance did it bring the clasping power of its abdomen into requisition. Another species was of a triangular shape, and of the colour of dead sandalwood, stripped of its bark, on which it was caught.

A slender and pale yellow-coloured scorpion lives under stones along the cliff top, and among dead timber in other parts of the Plateau. A large centipede was taken from the stomach of a *Grammatophora,* the only example observed.

Land Mollusca.—In such districts as I have described the presence of land snails is paradoxical; yet, nevertheless their prodigious abundance, even on the sterile portions of the Bunda Plateau, is one of those features which has not escaped the observation of some of my predecessors. Eyre noted the profusion of snail shells along the line of his march, but incorrectly referred them to fresh water forms. (See ante p. 101). The species most conspicuous for their abundance are *Helix nullaborica*, n. sp., and *Bulimus indutus*, Menke, *var. nov.*; they may be gathered by the barrow-loads under the larger bushes, and are thickly strewn over the open country; indeed, it is no exaggeration to state that every other step that is taken in walking will crush down a snail shell. But living examples are rare except in very favourable situations; they are to be obtained by pulling up the bushes by the roots, alongside of which they bury themselves to the depth of an inch or two. Here they may be said to dwell in a moist atmosphere during æstivation, as the dew collected on the twigs, when in sufficient quantity gathers together and trickles down the stem, and thus renders humid the soil immediately about the base of the bush. *Bulimus indutus* possesses an advantage over its congeners in closing the aperture of its shell by a testaceous epiphragm, which must more securely prevent dessication of the animal than if the aperture were closed by the filmy structure which is formed by the other species. Another South Australian Bulimus, *B. Mastersi*, which extends westward as far as the sandhills at the head of the Bight, constructs a similar defensive armature. The rarity of living examples of these snails forces one to the inevitable conclusion that the immense numbers of their dead shells, both on and beneath the surface of the soil, represent the accumulation of centuries of generations. The snails seem to have no enemy; and in a country where the forces of nature appear to be so equable, the preservation of their shells for long periods of time is not a matter for wonder.

*Helix Nullarborica*, *Bulimus indutus*, and *B. Adelaidæ* occur over the whole of the Plateau traversed by me. *Helix cyrtopleura* is also abundant, but more restricted, and, unlike the other species, is confined to the Plateau, where it chiefly affects the rock surface and debris of the western part of the Bunda cliffs, and about the caverns and stony ground inland. *Pupa australis* occurs over much of the better lands. All the above, excepting *Helix cyrtopleura* live in the sandhills at the head of the Bight, at Mundyarra, near Wilson's Bluff, and at Eucla, where they are accompanied by *Helix arenicola*, Tate, and *Pupa Maryaretta*, species not seen on the Plateau. Of the above species *Bulimus indutus* is an addition to the South Australian fauna, and *Helix Nullarborica* is new to science. *Bulimus Adelaidæ*, *Pupa australis*, and *Helix arenicola* are the most widely diffused of our land snails.

## Marine Conchology around the Head of the Great Bight.

The littoral life in these waters is that which prevails on the rough water shore throughout the southern coast of the continent. The species are few in number, though individuals abound. The majority of them are characterised by thick tests. Judging from the shells cast up upon the limited beach-line facing the ocean, the laminarian and deeper water forms are not so numerously represented as in the quiet waters of Fowler's, Streaky, and other bays.

The rocks uncovered at low tides are inhabited in the upper region by *Littorina caerulescens*, *Siphonaria Diemenensis*, *Acmæa alticostata*, *Patella tramoserica*, *P. Gealei*, **Trochocochlea chloropoda* (Tate), *T. constricta*, *T. striolata*, *Chiton petholatus*, *Mytilus Menkeanus*, and *M. hirsutus*, amongst which nestles **Lasea rubra* (Mont.) In the lower region live *Nerita atrata*, *Turbo undulatus*, *Diloma odontis*, *Acmæa septiformis*, *Purpura textiliosa*, *Cominella alveolata*. The sandy shore is the habitat of *Natica Baconi*, **Donax* (cf.) *epidermia* (small, with denticulated margins), *Donacilla præcisa*, *D. elongata*.

The commoner and the conspicuously-large shells which are cast up on the sandy beaches at the Head of the Bight, near Wilson's Bluff, and at Eucla are:—*Triton Waterhousei*, **Melo Miltonis* (Gray), *Cassis fimbriatus*, *Conus Anemone*, *Turritella clathrata*, *Amalthea conica*, *Phasianella bulimoides*, *P. ventricosa*, *Clanculus gibbosus*, *Thalotia picta*, *Gibbula Preissiana*, *Turbo lamellosus*, *Haliotis glabra*, *Bulla oblonga*, *Mactra rufescens*, *M. pura*, *Arcopagia decussata*, *Chione strigosa*, **C. Victoriæ* (T. Woods), *Marcia faba*, *Soletellina epidermia*, *Cardium cygnorum*, *Modiola australis*, *Arca lima*, **A. trapezia* (Lamk.), *Pecten asperrimus*, *Spondylus tenellus*, and *Cuneus galactites*. *Retepora phœnica*.

Those marked with an asterisk in the above lists have not previously been recorded for South Australia, though known to me as occurring elsewhere in our waters. One species only I consider to be new to science, I have named it *Trochocochlea chloropoda*.

Beyond the limits of the coast-line of Bunda Cliffs, especially in the sheltered bays to the east, the molluscan life is very rich, and the collections obtained at Fowler's and Streaky Bays contain several novelties and many forms hitherto thought to be confined to the eastern shores of the continent. The consideration of these will be reserved for a separate paper.

### Explanation of Plate IV.

Fig. 1. Section from the Pidinga rock basin, bearing S.W., distance seven miles. Vertical scale one-fourth inch to 100 feet. Strike of metamorphic rocks N.N.E.

Fig. 2. Diagramatic section near the Head of the Bight, view facing S.W. Vertical scale, 80 feet to one inch (see page 114).

Fig. 3. Profile of Wilson's Bluff, Bunda Cliffs (see page 105). Vertical scale, 100 feet to one inch.

# Zoologica et Palæontologica Miscellanea,

## CHIEFLY RELATING TO SOUTH AUSTRALIA.

By Professor Ralph Tate, Assoc. Lin. Soc., F.G.S., Corr. Memb. Acad. Sc., Philadelphia, Roy. Soc. Tasmania, &c.

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## ON A NEW GENUS OF FOSSIL LAMELLIBRANCHIATA.

### Family Mactridæ.

### Genus Zenatiopsis, *nov.*

Etymology.—*Zenatia*, a genus of Mactridæ; and *opsis*, like.

Type.—*Zenatiopsis angustata*, nov. spec. Miocene. Australia.

Shell equivalve, inæquilateral, oblong; umbo anterior, *supported internally by a thick rib*, extending, with a slightly backward inclination, half way across the valve; narrowly gaping at both ends; cartilage plate prominent; cardinal teeth distinct, no lateral teeth; pallial sinus deep, horizontal.

*Zenatiopsis* combines the form and internal appearance of *Machæra* with the hinge characters of *Zenatia*; the resemblance of the only known species to *Zenatia acinaces* is very great, but the presence of an umbonal rib, like that in *Machæra*, is a valid reason for not regarding it as congeneric therewith. It is distinguished from *Vanganella*, as *Zenatia* is, by the dentition; whilst the anterior divergent rib of *Vanganella* supports the cartilage plate with which it is confluent; the internal rib of *Zenatiopsis* is an umbonal support, and arises from beneath the cardinal teeth.

The anterior adductor scar is close up under the hinge line as in *Zenatia*, and is bounded on the posterior side by the umbonal rib.

Zenatiopsis angustata, *nov. spec.* Pl. v., figs. 6a, 6b.—Shell thin, compressed, narrowly oblong, back slightly convex; anterior end very short and rounded, posterior long rounded. Umbo small, apiculate. Dorsal and ventral margins nearly parallel. Surface shining, marked by a few slender plications of growth, and numerous fine coincident striations.

Dimensions of a large example from the "Upper Murravian":—

| | |
|---|---|
| Total length ... ... ... | 1·8 inch |
| Length of anterior side ... | ·25 inch |
| Height ... ... ... ... | ·6 inch |

Locality and Horizon.—The older tertiary of Muddy Creek, Hamilton, Victoria, and the contemporaneous "Upper Murravian," near Morgan (North-West Bend), on the River Murray. *(Tate.)*

*Z. angustata* is very much of the shape of *Zenatia acinaces*, Quoy, recent New Zealand and New South Wales, but it is much narrower, more attenuated posteriorly, and the anterior side is rather longer and not so abruptly arched. Specimens from the River Murray cliffs have thin, fragile, semi-pellucid tests; whilst those from Muddy Creek are thickish and opaque, and of larger dimensions. Similar differences are found among living species inhabiting the laminarian zone of the comparatively still waters of land-locked bays, and of the rough waters of the open coast line.

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## ON SOME RECENT AND FOSSIL KELLIADÆ FROM SOUTH AUSTRALIA.

Lepton crassum, *nov. spec.* Pl. v., fig. 9.

Shell thick, transversely oval, moderately convex; umbo post-median moderately inflated. Surface smooth, but, viewed under the lens, with narrow equidistant sulci and flat plications, punctatedly impressed in the grooves, particularly on the posterior and anterior sides. Anterior and posterior margins rounded, ventral margin nearly straight, dorsal slightly arched. Length ·25, breadth ·18 inch.

In the only valve, a left one, found of this species, there is a small cardinal tooth in front of the small cartilage pit, and the two laterals are elongated and erect.

Locality and Horizon.—River Murray Cliffs near Morgan (North-West Bend), Upper Murravian series.

Lepton planiusculum, *nov. spec.* Pl. v., fig. 12.

Shell minute, quadrately ovate, compressed, nearly equilateral, posterior side a little the longer; umbo prominent, acute; surface marked with strong folds of growth, which are broader and more elevated in the umbonal region, and very finely concentrically striated.

Right valve with divergent lateral teeth of equal and moderate size, between which is the broadly triangular cartilage pit.

Dimensions.—Length, ·175; breadth, ·15 inch.

Locality and Horizon.—In a sandy layer in the limestones of the Upper Aldinga series (Miocene), on the south side of Port Willunga Jetty.

This species comes near to *L. australe*, Angas (see p. 13), from which it differs in shape, in being more equilateral, and in its strong folds of growth, and by its more produced umbo and umbonal ridge.

LEPTON TRIGONALE, *nov. spec.* Pl. v., fig. 5.

Shell triangularly ovate, pellucid, shining, yellowish-brown with contained animal. *Sculpture*, finely shagreened on the anterior and posterior sides, smooth in the middle, concentric undulations slender and rather distant. Umbones produced, small and acute ; a little posterior. Ventral margin straight, or very slightly incurved, a little compressed medially. Hinge small ; right valve with a large ligamental pit and two stout diverging laterals, no cardinal tooth ; left valve with a minute ligamental pit, a small cardinal tooth adjacent, in front of which is a tuberculated lateral tooth, the posterior lateral is elongated, but not prominent. Dimensions of a very large specimen —Length, ·15 ; breadth, ·14 in.

Its triangular shape removes it from *L. translucidum* (Sow.) of New Caledonia, but allies it with *L. Adamsi* (Angas) and *L. concentricum* (Gould) of New South Wales. From the first it differs by the absence of the wide posterior plications, and its smaller size ; from the second by its more symmetrical shape, absence of epidermis, less marked concentric sculpture, and in its dental characters. *L. australe*, Angas, is of a different type.

HABITAT.—Shell sand. Holdfast Bay, St. Vincent's Gulf (very common) ; Port Lincoln, and Streaky and Fowler's Bay on the west coast (Tate).

LEPTON AUSTRALE (Angas).

*Ref. L. australis*, Proc. Zool. Soc., tab. liv., fig. 14, p. 863, 1878.

To the original diagnosis I would add a few characters, chiefly supplied by larger examples than the types. The texture of the shell is transparent, and the sculpture consists of delicate microscopic striæ coincident with the undulations of growth, and radiating from the umbo, which is decidedly anterior. Antero-dorsal margin more oblique than as in fig. Left valve with diverging lateral teeth, the posterior one large and erect, the other inconspicuous ; no cardinal tooth. Ligamental pit deep in both valves, the right with divergent lateral teeth of equal and moderate size.

Dimensions—Length, ·375 in. ; breadth, ·310 in.

*Habitat.*—Dead shells on beach, and from six fathoms water, Holdfast Bay ; among shell sand, Salt Creek, St. Vincent's Gulf ; and among shell sand, Streaky Bay (Tate). Only a few specimens. Fossil in the Pleistocene shell limestones of the Port Adelaide Creek, not uncommon (Tate).

Lasæa rubra, (Montague).

Whether the little shell called *Poronia australis* by Sowerby is distinct from the typical European species above named must be left for more critical comparisons than I have been able to make. But now that the distribution of *L. rubra* has been better ascertained, and its existence in the Southern Hemisphere thoroughly authenticated, there seems very great reason to believe that several species have been founded on examples from our Australasian waters of this ubiquitous species. Forbes, P. Carpenter, and other distinguished conchologists were agreed as to its occurrence on either side of the N. Atlantic, in the Mediterranean, and in the Indo-Pacific region. Jeffreys has just announced its presence in Korea Strait, along with some other species common to the N. Atlantic and N. Pacific Oceans; and has ventured to express the opinion that these forms have originated in high northern latitudes, and have found their way to Japan on the one side and Europe on the other by means of a bifurcation of the great Arctic current. Jeffreys, moreover, extends its range to the Straits of Magellan and to the Islands of St. Paul and Amsterdam.

According to Gray, *Cyclas australis*, Lamk., from the Isle of Timor, with a variety from King George's Sound (Peron), is identical with the *Cardium rubrum* of the earlier English author; but so far as one can gather from Lamarck's diagnosis it is not certain that it is so, as Lamarck has not mentioned the station of his species. Deshayes considers the shell to be a *Pisidium*.

The *Lasæa australis* (Sowerby) inhabits New Caledonia (Sowerby), New South Wales (Angas), Tasmania (Woods); and I have collected it from Cape Northumberland to Eucla, nestling among mussels or under loose stones, and in the crevices of rocks above high-water mark; and have received specimens from King George's Sound.

The South Australian and King George's Sound examples are smaller than those from Tasmania, but exhibit considerable variation in sculpture; in some it is reduced to microscopic concentric striæ, and in others it is in the form of thick ribs. The colour is sometimes white, though the red stain along the hinge line remains. For these reasons, I cannot select any valid character by which to separate *L. australis* and *L. scalaris* (Phil.) from one another, and these names must go to swell the long list of synonyms of *L. rubra*.

Pythina gemmata, *nov. spec.* Pl. v., fig. 8.

Shell minute, oblong, inequilateral, thick, pellucid. Posterior side the shorter, roundedly truncated; anterior side produced, rounded. Umbo subinflated. Ventral margin nearly straight. *Sculpture*, as viewed under an inch objective; anterior and posterior sides with divaricating granulose plicæ united in the median region by transverse rows of granules; the whole surface with regular incised lines coincident with the edge of the shell.

Interior of right valve with a bifid cardinal tooth in front of a ligamental pit, laterals one on each side stout and elongated.

Length, ·09; breadth, ·06 inch.

*Habitat.*—Shell sand Fowler's Bay, two right valves (*Tate*).

The shape and sculpturing recalls some *Goniomyæ*, in the latter character particularly of *G. heteropleura*, Ag., with this difference that the *en chevron* plicæ are inverted.

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## DESCRIPTIONS OF NEW SPECIES OF SOUTH AUSTRALIAN PULMONIFEROUS SNAILS.

HELIX SUBSECTA, *nov. spec.* Pl. v., figs. 2a, 2b.

Shell umbilicated, depressly orbicular, nearly discoid, solid, somewhat rugosely plicated, and obscurely but densely longitudinally striated, more conspicuously so on the anterior half of the body whorl. Colour greyish-white, somewhat porcellanous; epidermis? Spire slightly convex, whorls five; last whorl rounded at the periphery, anteriorly much depressed. Peristone thin, reflected, with an acute edge, but not thickened, nearly entire; aperture longitudinally ovate. Umbilicus large; its breadth being about one-fifth the major diameter of the base of the shell.

*Dimensions.*—Major diameter, ·625; minor diam., ·5; height, ·25 of an inch.

*Locality.*—Collected by Mrs. Kreusler, an indefatigable entomologist, in the Port Wakefield Scrub.

This species stands alone among the Australian Helices in its deflected aperture and almost entire peristome, associated with a depressed spire and open umbilicus.

HELIX NULLARBORICA, *nov. spec.* Pl. v., figs. 1a, 1b.

*Shell* narrowly umbilicated, globosely conic, very thick, surface of a dirty white colour, coarsely and closely wrinkled transversely, interrupted by equidistant incised lines, whorls $4\frac{1}{2}$, rotund, and just perceptibly flattened at the suture, which is impressed. Last whorl somewhat inflated, descending but little in front, base convex. Aperture oblique, sub-circular, peristome sub-acute, slightly reflected, margins joined by a callus; columella margin thickly dilated above, and nearly covering the umbilicus.

Major diameter, $\frac{3}{4}$ inch; minor diam., $\frac{13}{20}$ths of an inch; height, $\frac{3}{4}$ of an inch.

*Animal.*—Foot brownish-grey, muzzle black with white spots, tentacles black, collar grey and creamy white.

*Habitat.*—In great profusion over the Bunda Plateau, and extending to the scrubby sandhills on its east, and to the Roe Plains, at the foot of the Hampton Range, in Western Australia.

*Affinities and Differences.*—*H. Nullarborica* has considerable resemblance to *H. Angasiana*, differing from it, irrespective of coloration, in its more globose form, minute umbilicus, in its wrinkled surface, and longitudinally impressed lines, and in the callous covering on the pillar.

The ridges of growth of the shell of *H. Angasiana* are regularly curved, and are interrupted by close set striæ, giving rise to a granulated appearance under the lens; but in *H. Nullarborica* they are wavy and varied in the degree of coarseness, whilst the incised longitudinal lines are distant from 20 to 25 on the body whorl, and help to give that pitted appearance to the shell which is observable by the unaided eye. The shell is moreover remarkable for its excessively thick test, for its semi-fossilized aspect, and is devoid of an epidermis. It is very constant in form and colour, though in size it presents great differences; the dimensions given are those belonging to a specimen of the common size. I may add, to avoid misapprehension on the subject, that I gathered many living examples.

The specific name is adopted from that of the treeless portion of the Bunda Plateau known as the Nullarbor Plain.

Bulimus sinistrorsus, *nov. spec.* Pl. v. fig. 4.

*Shell* sinistral umbilicated, oblong turretted, very thin, translucent, yellowish-horn coloured, showing under the lens regular fine transverse striæ. Spire elongated, gradually tapering, rather acute, whorls five, moderately convex, last whorl equalling one-third the total length of the shell. Aperture somewhat ovate; peristome white expanded, especially the columella margin; left margin with a white tooth-like callosity in the angle.

Length, ·18; breadth, ·06 inch.

*Animal* unknown.

*Habitat.*—Under small bushes on the sandy margin of the salt swamp at Peelunibie, Head of the Great Australian Bight, 50 examples observed.

This shell, though it resembles *B. Adelaidæ* in a few particulars, yet it cannot be regarded as a reversed form of it, as its regularly increasing whorls alone prove its distinctness. It may be questioned—Would it not be better to refer it to *Balea?* But its close affinity to *Bulimus Adelaidæ* induces me to place it near that species. *B. sinistrosus* is a very different type of shell to *Balea australis*, Forbes, which is a decided connecting link with *Clausilia*, whilst the present species is a divergence from the typical Bulimi towards *Balea*.

Bulimus indutus, *Menke*, var. pallidus, *nov.*

The large Bulimus so profusly abundant over the Bunda Plateau agrees so accurately in its dimensions with *B. indutus* of Western Australia that, despite the differences of coloration, I am constrained to regard them as of one species. Our shell has a white semi-fossilized appearance, and its columella is grayish-white, and the aperture is dull-white within. Menke describes the type as *fulva albida*, and the aperture as white within. Cox gives it a yellow epidermis, and the columella flesh-coloured.

The classification of the Australian Bulimi adopted by Dr. Cox places *B. dux* and *B. indutus* in different sections, an arrangement with which I cannot agree, as I believe that the two species are not more distantly related than *B. indutus* is to the variety above described. *B. Mastersi* belongs to the same natural group.

*B. indutus* var. *pallidus* is widely diffused over the Bunda Plateau, and the dead shells are to be met with in such prodigious numbers in many places that a barrow-load could be gathered within an hour, and over the less sterile portions a foot can hardly be set down without crushing one. Westward it extends to the Roe Plains, and eastward to Coymbra, and inland from thence for a few miles. It does not inhabit the country east from Fowler's Bay.

Plecotrema ciliata, *nov. spec.* Pl. v., figs. 7a 7b.

Shell imperforate, fusiformly ovate, solid; shining brown-black, with a narrow light-coloured band near the suture, and between which is a reddish-coloured one. Surface ornamented with incised longitudinal lines and regularly wrinkled transversely; at the intersections of the lines, punctatedly impressed and ciliated; the cilia, yellowish-brown, filiform. Spire conoidal, rather pointed. Whorls seven, scarcely convex, with one shallow groove near the suture, the last forming three-fourths of the total length. Pillar with a posterior white tubercular tooth, and an anterior compressed spiral plait; columella with a similar plait, but smaller; outer lip with two tubercular teeth. Columella expanded and reflected at the lower angle to form a false umbilicus. Length, ·3; breadth, ·16.

Animal with the foot and neck bluish-grey; muzzle with dark annular streaks, short, broad, and flattened, slightly sinuated in front; tentacles with dark annular coloration, short, not extending to front of muzzle, pointed, dilated at the bases. Eyes at the bases of the tentacles on the upper side, but slightly on the inner side of the axis of the tentacle, they are surrounded by a circular colourless space; foot short and pointed posteriorly.

*Habitat.*—Mangrove swamps about Port Adelaide ; sheltering under shrubby-samphire, just above high-water mark, in company with *Alexia meridionalis*, Brazier, but not so abundant as that species (*Tate*). Among shell-sand, north side of Streaky Bay, probably inhabiting the extensive samphire flat about Acraman Creek, Streaky Bay (*Tate*).

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## DESCRIPTION OF A NEW SPECIES OF PHYLLOPODOUS CRUSTACEAN.

LEPIDURUS VIRIDULUS, *nov. spec.*

Animal, including flap of tail-segment, about an inch long, carapace rounded, elongate oval, of a brownish-green colour, covering the whole abdomen, excepting flap of tail-segment; keeled towards the extremity, ending in an acute point, lunately notched posteriorly, and sharply and conspicuously hooked on its margin. Front and lateral margins of the carapace smooth and thickened. The rings of the abdominal segments, dark-brown, are beset with stout spines, equi-distantly placed all round, and directed backwards. The flap of the tail-segment has a blunt keel along its whole length, with blunt prominences, and its edges are ciliately serrated. The filaments of the tail are about half the length of the body, and are clothed with fine cilia.

*Habitat.*—Collected by Thomas Tate, October 1878, in the flood waters of the "Reedbeds," near Adelaide.

Two Australian species of the genus have been described, *L. viridis*, so-called from its colour, inhabits Tasmania, and was diagnosed by Dr. Baird, Proc. Zool. Soc., 1850; and *L. Angasi*, of the same author, 1866, which is of a pale horny colour, and is common in the rain pools about Adelaide. *L. viridis* is characterised by its fine green colour, by its oval carapace covering less of the body than in *L. Angasi*, and the edges of the lower half of its length being serrated. *L. Angasi* is distinguished by its horny colour, its rounded carapace covering nearly two-thirds of the body, and by the smooth edges of the sides of the carapace.

*L. viridulus* differs from *L. Angasi* in colour, in the carapace covering more of the abdomen, its keel limited to the hinder part, and in the narrower and more spathulate tail flap.

# NOTES ON THE CONCHOLOGY OF KING GEORGE'S SOUND.

During a recent visit to King George's Sound, Western Australia, my friend and colleague, Professor John Davidson, was kind enough to gather for me about a gallon of very coarse shell sand. The gathering has yielded thirty-eight species of mollusca, and as some of them are new and others not known to occur so far to the west, I have thought it worth while to place on record the following observations :—

King George's Sound is classic ground to the conchologist, as many of the earlier known Australian shells were obtained at this place. It was visited by the French surveying ship, commanded by Peron, and twenty-eight of the species then collected were described by Lamarck in his "Animaux sans Vertebres," 1818-1822. Its waters were again explored by a French surveying ship, the Astrolabe, and thirty-seven species then obtained were described by Quoy and Gaimard in the Zoological account of the voyage (1830-1833). Menke, in his "Molluscorum Novæ Hollandiæ," 1843, describes and refers to 185 species as belonging to Western Australia, some of which are recorded as inhabiting King George's Sound. These are the chief sources of information having reference to the marine shells of the west and south-western shores of this continent, and I am not aware of any attempt made to furnish a complete list of the shells of Western Australia. Of the shells not previously known to occur I record the following :—

TROPHON PAIVÆ, *Crosse.* Inhabits St. Vincent's and Spencer's Gulf, and has been collected at Port Elliot. Occurs in New South Wales.

TROPHON, *species undescribed.* Lives in the mangrove-swamp about Port Adelaide Creek.

DRILLIA HARPULARIA, *Desmoulins.* St. Vincent's Gulf, Lacepede Bay.

BITTIUM LAWLEYANUM, Crosse. Occurs in New South Wales, Victoria, Tasmania, and South Australia.

TURBONILLA ERUBESCENS, *n. sp.*

ALABA PAGODULA, Adams. Till now peculiar to St. Vincent's Gulf.

DIALA LAUTA, Adams. Very common in St. Vincent's and Spencer's Gulfs.

DIALA IMBRICATA, Adams. Specimens obtained by me from St. Vincent's Gulf have been so named by Mr. G. F. Angas.

CAPULUS SUBFUSCUS, Gray. St. Vincent's Gulf.

CLANCULUS RUBENS, Adams. South Australia and Tasmania.

THALOTIA CONICA, Gray. Tasmania, Victoria, and South Australia. Common at Fowler's Bay.

Utriculus apiculatus, *new species.*

Cylichna pygmæa, Adams. St. Vincent's Gulf.

Donacilla præcisa, *Deshayes.* South Australia and Tasmania.

Lasæa rubra, Montague. (See p. 132.)

Mytilus Menkeanus, Phil. Common in South Australian waters.

Modiola flavida, Reeve. St. Vincent's Gulf.

Mysella donaciformis, Angas. This New South Wales species I have collected abundantly at places in St. Vincent's Gulf. It has been identified by the original describer.

## Descriptions of New Species.

Turbonilla erubescens, *nov. spec.* Pl. v. fig. 10.

Shell of the same dimensions as *T. fusca*, Adams; from which it differs in the more numerous and less regular transverse costæ; its colour is a transparent light-horn, and a narrow rufous band winds round the centre of the whorls. On the body whorl a similar band is situated below the periphery. The columella lip is ruby-tinted.

It agrees in its coloration with *T. festiva*, Angas, but that shell is not coloured on the columella, and its whorls are rounder, aperture wider, and the suture less impressed.

Dimensions of a shell of ten whorls:—Length, ·25; breadth, ·05 inch. The relative proportions of the length to the breadth are in *T. erubescens* 40 to 8, and in *T. festiva*, 40 to 15.

Utriculus apiculatus, *spec. nov.* Pl. v. fig. 3.

Similar to *U. eumicrus*, Crosse, but distinguishable by its sunken spire, the papillary apex of which is exserted beyond the level of the body whorl. The anterior extremity of the shell is more gradually tapering, and the shoulder of the body whorl is less abruptly arched, consequently *U. apiculatus* is more fusiform than its ally. It is also much larger.

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# DESCRIPTIONS OF TWO NEW MARINE GASTEROPODA FROM SOUTH AUSTRALIA.

Trochocochlea chloropoda, *nov. spec.*

Animal like *T. striolata*, but the under side of the foot is green, and the muzzle and upper side of foot is black.

Shell like *T. constricta*, but without longitudinal plications and sutural constrictions; very thick. Colour, yellowish-white or grey, with surface marked with curved striæ of growth, and under the lens with numerous longitudinal striæ.

Outer lip thin, broadly bevelled on the inner side, of a black colour; perlaceous interior with nine longitudinal, narrow, roundly elevated porcellanous ribs; columella, white, broad, and arched; under side of body whorl black.

It is of the same size as *T. constricta*, and aged examples have the elongate-turbinate shape, as is the case with those of that species.

*Habitat and Station.*—On rocks below tide marks, Coymbra, Head of the Bight, and near Wilson's Bluff. (*Tate*, many examples.)

Ethalia (?) cancellata, *nov. spec.* Pl. v. figs. 11a 11c.

Shell lenticular, obliquely-depressed; spire very slightly raised; hyaline, upper and under surface transversely striated and cancellated by longitudinal striæ (the latter vary much in strength, and in some specimens are obsolete); whorls embracing, three and a half; suture deep and narrow, bordered by an opaque white band; body whorl much larger than preceding one, that of the adult shell enveloping the spire. Aperture oblique, crescent-shaped, broader than high. Base flattish or slightly convex, but concave around the umbilical region. Columella broadly thickened, excavated, and spread over the umbilical region to form a small, round, depressed callosity.

Major and minor diameters—·085 and ·065 inch.

*Habitat.*—Shell sand, Holdfast Bay, St. Vincent's Gulf; Streaky and Fowler's Bays in the Great Australian Bight, *common* (Tate).

The species may be described in brief as a lenticular hyaline *Rotella* with a cancellated sculpture. So far it would seem to fall in with Adams's genus *Ethalia*, whilst the thin callous extension of the body whorl over the spire indicates a relationship to *Teinostoma*; but as the latter genus was founded for the reception of rotelloid shells with distorted body whorls like *Cyclops* and *Streptaxis* I prefer to assign the new shell to the former genus.

Angas has recently described a turbinated *Ethalia (E. Brazieri)* from New South Wales; *E. Tasmanica* is not only questionably Australian, but its generic position is doubtful. The genus now includes sixteen species, all of which, with the exception of *E. Brazieri* and *E. cancellata*, inhabit the coasts of Japan, China, and Mexico.

## Explanations to Plate V.

Fig. 1 Helix Nullarborica; *a.* side view; *b.* basal aspect, *nat. sizes.*

Fig. 2. Helix subsecta; *a.* side view; *b.* basal aspect, *slightly enlarged.*

Fig. 3. Utriculus apiculatus, much enlarged.

Fig. 4. Bulimus sinistrorsus, *much enlarged.*

Fig. 5. Lepton trigonale, magnified.

Fig. 6. Zenatiopsis angustata; *a.* exterior of a right valve; *b.* interior of a portion of left valve, *nat. sizes.*

Fig. 7*a.*-*b.* Plecotrema ciliata, much enlarged.

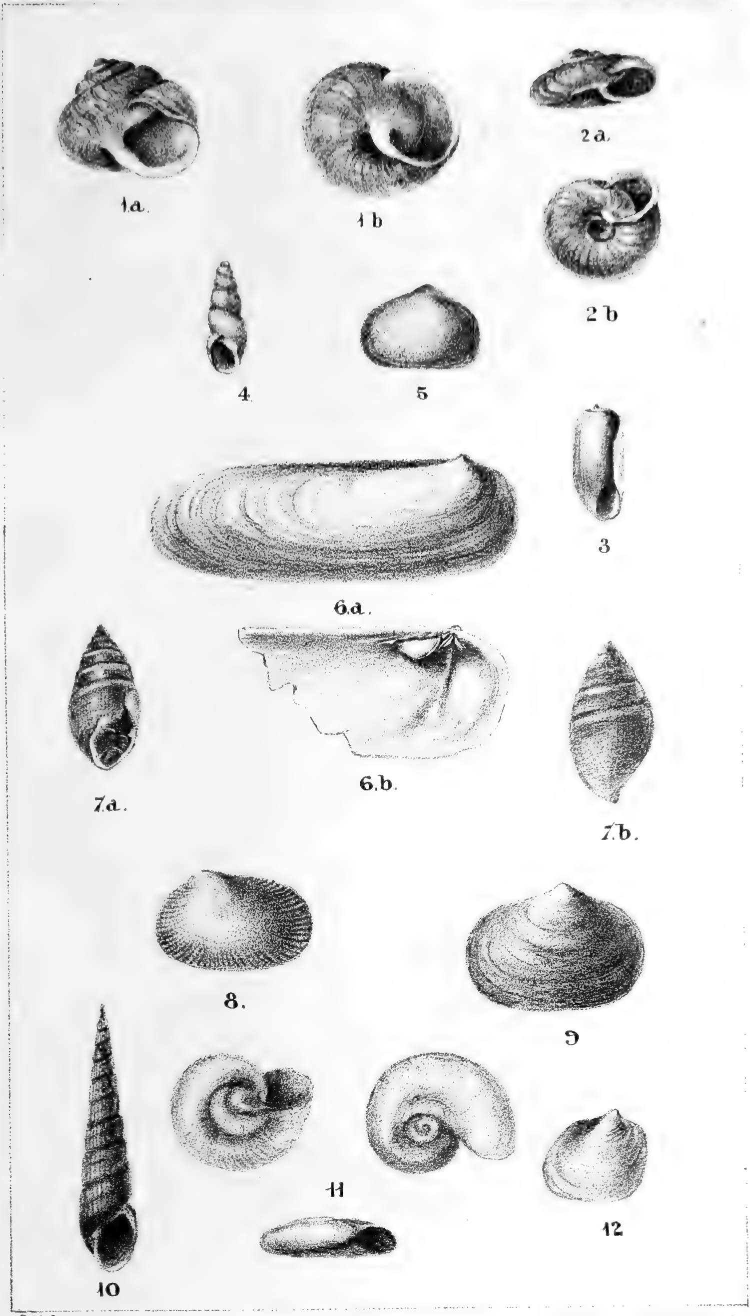
Fig. 8. Pythina gemmata, magnified.

Fig. 9. Lepton crassum, much enlarged.

Fig. 10. Turbonilla erubescens, much enlarged.

Fig. 11. Ethalia cancellata, *a.*-*c.*, magnified views.

Fig. 12. Lepton planiusculum, enlarged.




C. H. STROTHER DEL: J. WILLIAMS, LITH. ADELAIDE.